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Reporting Progress

Ever since the publication of the Garrett Report we have taken a close personal interest in the general situation of the foundry industry, *vis-à-vis*, with its recommendations. We have been agreeably surprised at the increasing tidyness everywhere apparent. The dust problem is not noticeable where the foundry shop is reasonably high. This is more important than has been stressed in the Report. Discussing this problem with French foundry managers, we learnt that, in some regions, the severity of the winter weather renders the heating of a lofty shop extremely difficult. In Scandinavia, the climatic conditions will no doubt accentuate the difficulties, and the allied problem of ventilation. So far we have encountered no fume problems.

A second feature now noticeable is the general increase in the number of personal lockers being provided. More would be installed but for the price. Here it is well worth noting that in the space of but a few days, foundry owners quoted to us offers, the price range being so wide as to warrant the appelations of ridiculously dear, and, quite reasonable. Of course, we were unable to enter into the quality factor, which may have been the reason for the wide differences noted. Commendable progress is also being made for the provision of modern washing and bathing facilities. Even some quite ordinary " family " businesses have provided a shower cubicle, an action which is much appreciated by the fettlers.

Whilst the suggestions of the Garrett Report are excellent, it must not be forgotten that the first duty of a foundry is to make castings, and, moreover, to do so at profit. A derelict foundry possessing modern amenities makes no contribution to progress, but hampers the rest of industry. In this connection, it is not pleasant to read in the " Iron Age " that during the last six months more than one hundred of America's 2,500 grey-iron foundries have failed. Thus, it is better policy for the industry to develop naturally, having always in mind the institution of better amenities for the staff. Too hasty implementation may so increase the non-productive overheads as to cause financial embarrassment, if not failure. On the other hand, some of the suggestions, such as those relating to tidyness, are " money spinners." From much close observation, we are convinced that the average foundry owner is out to do his best, and no amount of compulsion could or would produce better results. Side by side, there must be a real effort made by the employees to respect and utilise the amenities provided. For years the managements have provided the fettlers with goggles and cleaning gang with spats, yet how many take advantage of them? For the time being moulders' boots are popular, yet it is germane to ask whether this is not a " hang-over " from the coupon system ! Yet we feel justified in stating that by and large good progress is being made.

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Book Reviews

The Ferrous Metal Industry in Germany (during the period 1939 to 1945), by G. Patchin and Ernest Brewin. Published for the British Intelligence Objectives Sub-committee by H.M. Stationery Office, York House, Kingsway, London, W.C.2, and elsewhere. Price 4s. 6d. net.

Being thoroughly wearied of reading the reports of the teams which visited Germany after the war, the reviewer welcomed this excellently condensed report of the enumerable publications available. Their task was indeed formidable, but the authors have certainly produced an easily readable book set out in logical order. Some 26 pages are devoted to foundry practice, and so far as can be remembered, nothing of importance has been omitted. It is a pity that all these teams concentrated on obtaining technical information whilst forgetting that commercial information would have been equally valuable, especially today. This book is much better value for money than those upon which it is based, and as a work of reference it should be included in the library of all the larger concerns in the industry.

V. C. F.

The Law of Trade Unions (Fourth Edition), by H. Samuels, M.A., Barrister-at-Law. Published by Stevens & Sons, Limited, 119-120, Chancery Lane, London, W.C.2. Price 7s. 6d. net.

The first edition of this book appeared in 1946, and the fact that it has already reached its fourth clearly indicates its worth and popularity. "The object of the latest edition is to present in brief compass an account of this branch of the law as it stands after the repeal of the 1927 Act," says the preface, and no better phraseology could be found to describe the contents.

THE FIRST CARGO of machine-cast pig-iron—3,296 tons—to come from India since the early days of the war, has been discharged at Newport, Mon.

THE "600" GROUP OF COMPANIES announces that Metalclad, Limited, has now centralised administration and manufacture at Stanningley Works, near Leeds. The company's new foundry at Morriston, Glamorgan, will produce the iron castings required. Also, it has been arranged that, in future, all sales of Metalclad woodworking machinery will be handled by the parent company of the group as world distributors. Export inquiries will, therefore, be dealt with by George Cohen, Sons & Company, Limited, Export Division, Wood Lane, London, W.12. Home inquiries will be dealt with at Sunbeam Road, London, N.W.10, and at the company's many branches throughout the country.

"Ready Reckoner" for Cupola Charges

The attention of foundry metallurgists and all concerned with the operation of cupolas is directed to the availability of the "Ready Reckoner" for cupola charges. This publication, which embodies the methods and calculation tables taken from recommendations of the T.S. 27 Sub-committee of the Institute of British Foundrymen, is in the form of a card suitable for the desk. Use of the "Ready Reckoner" simplifies the making-up of furnace charges to produce metal to a specified composition. Copies may be obtained free of charge on request from the Publishing Department, FOUNDRY TRADE JOURNAL, *49, Wellington Street, London, W.C.2.*

Institution of Production Engineers

Schofield Travel Scholarships

The Institution of Production Engineers announces the establishment of Schofield Travel Scholarships for graduate members. These scholarships, to be awarded for the first time in 1950, will entitle successful graduates to six months' study visits to the United States, the entire time being spent in industry. In future years study visits to other countries are also envisaged. The Institution will make all administrative arrangements, and will pay all travel and subsistence expenses in connection with the visits. The scheme was originally conceived by Mr. E. W. Hancock, M.B.E., of Humber, Limited, a vice-president of the Institution, due largely to whose untiring efforts this major award is announced. The title of the Scholarships pays tribute to the long and valued service of the president of the Institution, Dr. Herbert Schofield, C.B.E., B.Sc., Principal of Loughborough College.

Two scholarships will be offered, covering a six months' period from February to July inclusive. The council of the Institution reserves the right to make no award if the entries are not considered to be of sufficiently high standard. Graduates entering must be between the ages of 23 and 28 on January 1, 1950. Application forms may be obtained from the head office of the Institution, and should be completed and returned by candidates not later than October 15. Successful candidates will be required to devote the whole of their time in the United States to the project which they have selected. On their return they will be required to read a Paper and present reports.

Preliminary selection will be carried out by section committee, which will take into consideration reports from employers and educational establishments. The next stage involves the preparation of a Paper on: (*a*) the project which they propose to carry out if awarded a scholarship; (*b*) the detailed background of their own knowledge and experience in the subject, which they consider will enable them to make a profitable investigation of it. Selected projects must have a direct bearing on production, and, in particular, on that aspect of it with which the candidate is concerned at the time of entering for the award. Certain candidates will then proceed to the final stage, and will be required to attend a group interview. It is important to note that at all stages of the above procedure the personal qualities of candidates will be given equal consideration with their academic and industrial attainments.

THE NEXT—THE 54TH—Annual Congress of the American Foundrymen's Society is to be held in Cleveland, Ohio, from May 8 to May 12, 1950.

A Metallurgical Examination of a Cast-iron Cannon Ball*

By J. E. Hurst, D.Met., F.I.M., J.P., and R. V. Riley, Ph.D., B.Sc.

When this Paper was presented at the Annual Conference of the Institute of British Foundrymen at Cheltenham, DR. RILEY, introducing the subject, gave a prefatory historical note. It was, he said, interesting to reflect on the state of the iron trade at about the time the cannon ball had been founded. Views upon the period 1662-1666, were established with some certainty, as they were based upon the detailed manuscripts left by George Sitwell. This historian ironmaster was a prominent member of the Sitwell family, which still resided at Renishaw Hall, in Derbyshire, not far from the Author's works. The cannon ball itself came from a cast just prior to that time, some 300 years ago. Charcoal smelting was employed universally at that period. It was used also for heating the forge to make wrought iron, trees being cut from Sherwood Forest and from the well-wooded district around Sheffield to obtain the charcoal. Wages for general craftsmen then ranged from 1s. to 3s. a day, and it was interesting to note that in 1665 iron shot was being exported from Hull to the Continent at a price of from £8 to £10 a ton.‡ Owing to difficulties of transport and also because of the high cost, the furnaces were worked in winter and the products transported in summer. It often took a year and longer to send goods from the Midlands to London or a destination overseas. Another impediment to trading was the absence of banking accounts which rendered the payment of bills a most difficult operation.

During the Civil Wars the Cathedral Close of Lichfield sustained three sieges over the years 1643 to 1646. Garrisoned on behalf of the King early in 1643, it surrendered to the Parliamentary forces on March 5 of that year. In the following April, Prince Rupert, having taken the town of Birmingham, marched on Lichfield and laid siege to the Close a second time. Batterjes were erected to the North of the Close and after ten days' ineffectual attack, he at length drained the moat and sprung two mines, one of which being successful enabled him to "furiously storm the place." The garrison surrendered on April 21, 1643, and remained in the King's hands until early in 1646 it was again "harassed by the enemy" and surrendered to the Parliamentary forces on July 10, 1646†

From time to time cannon balls have been discovered in the neighbourhood of the Close, and one of these recently came into the possession of one of the Authors. As a specimen of a casting approximately 300 years old it was considered of interest to submit this to a metallurgical examination, and particularly to examine and record, not only the residual elements present in its composition, but also the content of hydrogen, oxygen, and nitrogen remaining after such a long period of preservation.

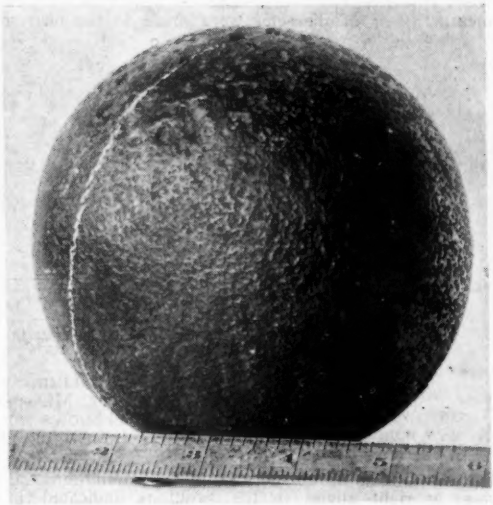


FIG. 1.—CANNON BALL SHOWING POSITION OF RUNNER: RISER ON THE TOP, WITH THE JOINT LINE MARKED BY CHALK (APPROXIMATELY HALF ACTUAL SIZE).

Visual Examination

The ball examined had a diameter of just under five inches, and was of iron. The surface was remarkably smooth and, although oxidised, was free from the thick layers of rust which might have been expected after 300 years. There still remained a very faint line running more or less continuously around a circumference of the ball, and this passed through a roughly circular

*A communication from the Research Department of the Staveley Iron & Chemical Company, Limited.

† See History and Antiquities of the Church and City of Lichfield Rev. Thos. Harwood. 1806.

‡The Chairman later pointed out that this was about four or six to one in ratio compared with the inflated price of the £ to-day.

Cast-iron Cannon Ball

area 2 in. dia., which was more pitted than the rest of the surface. Fig. 1 shows a general view of the cannon ball on which has been drawn a chalk mark following this line and passing at the top through the roughened area just described. If it be assumed that the ball was moulded in a two-part box which was subsequently placed on end for top pouring through a feeder/riser cut along the joint, this might account for the surface indications described. In the subsequent metallurgical examination this method of manufacture has been confirmed.

Dimensional Accuracy

To the eye, the ball appeared truly spherical, and when rolled on the floor it showed little bias. Check measurements of diameter were made to the nearest five-thousandths of an inch along two circumferential rings at right angles in the positions indicated in Fig. 2 (*a*) and (*b*). The readings obtained are given in Table I.

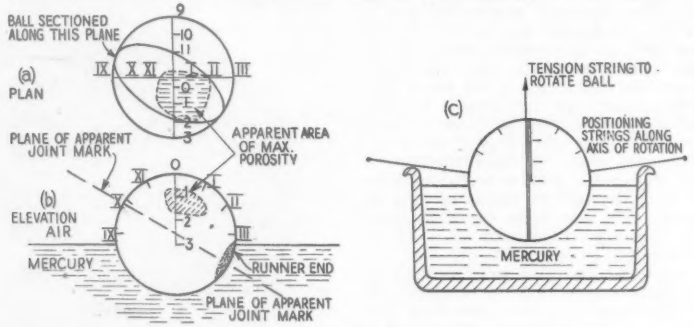


FIG. 2.—METHODS OF PRELIMINARY INVESTIGATION OF THE CANNON BALL; (*a*) AND (*b*) SHOW THE MEASURING POSITIONS, FLOTATION LINE AND JOINT LINE, WHILE (*c*) SHOWS THE METHOD OF FLOTATION AND ATTACHMENT OF TENSION STRINGS.

TABLE I.—*Measurements of Diameter of Cannon Ball.*

	(*a*) Greek numerals.	(*b*) Roman numerals.
Diameter on circumferential line shown in		
Position 1	4.930	4.925
2	4.925	4.945
3	4.900	4.955
4	4.910	4.945
5	4.935	4.920

It is clear that the ball, as a casting, was to a tolerance of plus or minus twenty-five thousandths of an inch, which, even on present-day standards, must be considered good. This assumes, of course, that there was no attempt at chipping or hand-grinding to shape, which on the whole is considered unlikely, especially in view of the prominence of the joint line and feeder/riser markings which were almost the only remaining blemishes apart from corrosion pitting.

Density of the Ball

Weight of the ball	= 14.25 lb. = 6,460 gm.
Average diameter of the ball	= 4.92 in.
Volume of the ball	= 64.5 cub. in. = 1,055 cc.
Density	= 6.13 gm. per cc.
Usual density of cast iron	= 7.6 gm. per cc.

The density of 6.13 gm. per cc. denoted that unsoundness was present in the ball, probably due to a shrinkage cavity, and it was decided to cut up the ball to discover the nature of the unsoundness.

The Out-of-balance of the Cannon Ball

An attempt was made to test for "out-of-balance" in order to discover along which section a cut should be made to strike the maximum internal porosity. For this determination the ball was floated in mercury and was found to have one equilibrium position only; when rotated or deflected from this upright position in any direction it quickly floated back to it. The stable floating position was such that the suspected joint plane was at an angle of 30 deg. to the horizontal, and the roughened-surface area corresponding to the suspected feeder head was partially submerged. The ball was, therefore, almost certainly porous and in a manner which removed the centre of gravity from the central position.

In order to discover the apparent zone of unsoundness and its relation to the suspected joint mark and feeder point, axes were marked on the surface of the sphere in two directions at right angles, intersecting at a point designated "O," which was the polar position or

top of the ball in its normal floating equilibrium position, as shown in Fig. 2(*a*) and (*b*). The ball was then rotated about each axis in turn by means of a light cord attached by wax. Positioning strings were attached at points diametrically opposite and in a plane at right angles to the direction of the rotational force, as shown in Fig 2(*c*). The rotational force was applied first in a clockwise direction and then anti-clockwise along each of the two axes in turn. The pull on the cord measured in gms. to rotate the ball though increments of 30 deg. is recorded in Table II.

On the results given in Table II it was assumed that the unsoundness was possibly in the region cross-hatched in Fig. 2, and the ball was sectioned across a

TABLE II.—*Force Required to Rotate the Ball through Angles of* 30 *deg*

(A) *Rotation around Axis IX—III*		
Force required to displace point 0 to points ..	1	2 gm.
	2	7 gm.
	3	14 gm.
Force required in opposite direction to rotate point 0 to points	11	2 gm.
	10	22 gm.
	9	31 gm.
	8	47 gm.
(B) *Rotation about Axis* 3–9.		
Force required to displace point 0 to points ..	I	Nil
	II	2 gm.
	III	9 gm.
Force required in opposition direction to rotate point 0 to points	XI	7 gm.
	X	39 gm.
	IX	Unstable

diameter calculated to pass through the zone of maximum unsoundness. The direction of the cut was almost at right angles to the supposed mould joint and passed through the rough-surface area thought to be due to the runner : riser.

Internal Unsoundness

On parting-off the two halves of the ball along the plane shown in Fig. 2, a zone of unsoundness was visible as in Fig. 3, which proved to be more central than had been expected from the out-of-balance tests. The cavity was not quite so large as might be imagined from Fig. 3, as some of the core fractured irregularly towards the completion of the cut, which gave an uneven fractured surface. The actual cavity was elongated in the plane of the supposed mould joint, and is the dark shadowed area in Fig. 3. The cavity was obviously due to shrinkage of iron on solidification, but it differed from most internal shrinkage cavities in that its surfaces were oxidised.

A test was made to discover whether the central shrinkage cavity in any way communicated directly with the atmosphere through unsound or porous areas in the bulk of the iron. A bell-shaped glass funnel was sealed on to the surface of each half of the ball in turn and air under a pressure of 6 cms. of mercury was confined in the funnel. Pressure readings after 12 hours showed that there was apparently no through connection between the central cavity and the outside of the ball. A similar test carried out with hydrogen gave the same results. The reason for the oxidised inner surface of the cavity was therefore not clear; it might of course be due to extremely minute pores in the iron which could not be detected in the above test or which did not exist at the time of examination; or be due to a passageway which might have existed in the metal removed when the ball was sectioned. The oxidation might also have been

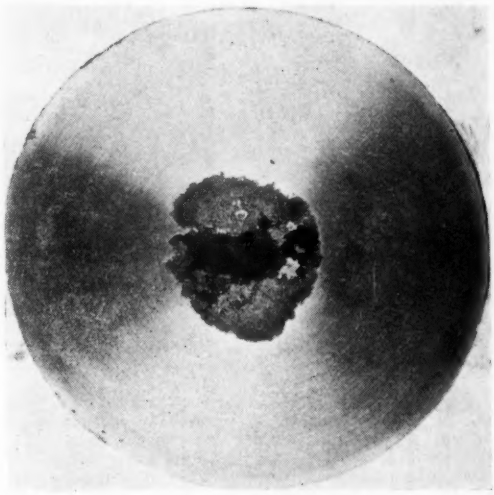


FIG. 3.—SECTION THROUGH THE BALL, SHOWING THE INTERNAL POROSITY, AND THE CORE WHICH WAS FRACTURED DURING PARTING-OFF (APPROXIMATELY HALF ACTUAL SIZE).

due to the residual gas in the cavity, but this phenomenon has not been noted previously with shrinkage cavities. If carbon-dioxide, water vapour, oxygen or other oxidising gas had subsequently diffused into the cavity, and the ball had been re-heated, as history suggests was done prior to the use of cannon balls as missiles, this might also account for the oxidised cavity. No corroborative evidence from the micro-structure could be obtained to support the theory that the ball had been re-heated after casting.

No wholly satisfactory theory can be advanced, therefore, which will account for the oxidised surface of the shrinkage cavity found in the cannon ball. The general nature of this central cavity is not uncommon, however; similar cavities would be expected in any spherical casting of this type unless special means were taken to feed the casting completely. By modern standards, the shrinkage cavity was quite centrally located, and compared favourably with cavities in cast-iron balls made at the present time.

Cast-iron Cannon Ball

Chemical Composition

By chemical analysis the cannon ball was found to be a phosphoric iron of similar composition to the iron used to-day for common engineering castings. The analytical results, shown in Table III, contain no unusual features except the sulphur which is probably lower than would be found in castings of this type to-day. The low sulphur may possibly be the result of charcoal smelting.

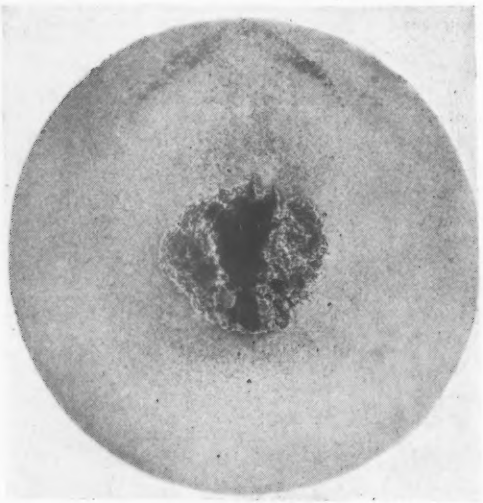


FIG. 4.—MACRO-ETCHED SECTION SHOWING THE "OPEN" STRUCTURE BENEATH THE RUNNER: RISER (APPROXIMATELY HALF ACTUAL SIZE).

TABLE III.—*Chemical Composition of the Cannon Ball.*

	Per cent.
Total carbon	3.20
Graphitic carbon	2.76
Combined carbon	0.44
Silicon	0.80
Sulphur	0.056
Phosphorous	1·12
Manganese	0.48

Gas Content of the Iron

The determination of the content of hydrogen, oxygen and nitrogen, was made by the vacuum-fusion method, and the results are given in Table IV.

TABLE IV.—*Gas Content of the Iron.*

Hydrogen	5.2 ml. per 100 gm. or 4.5 parts per million.
Oxygen	0.0032 per cent. or 32.0 parts per million.
Nitrogen	0.0065 per cent. or 65.0 parts per million.

It is noteworthy that after 300 years the iron retained 5.2 ml. per 100 gm. of hydrogen. It is possible, of course, that the hydrogen had become concentrated somewhat in the iron due perhaps to the absorption of nascent hydrogen resulting from surface corrosion during the time in which the cannon ball was lying in the ground. It is common for samples of ancient iron to yield on analysis quantities of hydrogen higher than the average for castings made to-day.* The hydrogen value recorded in this instance, although higher than the average for modern iron, was not larger than some individual results that have been obtained. The oxygen showed no unusual features. The nitrogen content is quite similar to the percentage yielded by a modern cupola-melted iron. Table V indicates this interesting similarity, which is in contrast to the nitrogen content of a blast-furnace iron.

TABLE V.—*Percentage Nitrogen Content as a Function of Melting Practice.*

Cannon ball.	Cupola irons.	Blast-furnace irons.
0.0065	0.0050 to 0.0100	0.0010 to 0.0060

The ranges for nitrogen given in Table V are obtained from a study of a large number of gas-content estimations carried out in the Authors' department during the last five years.

* "A Study of Residual Gases in Cast Iron." J. E. Hurst and R. V. Riley. *Proceedings of the Institute of British Foundrymen* 19.7/.[2]

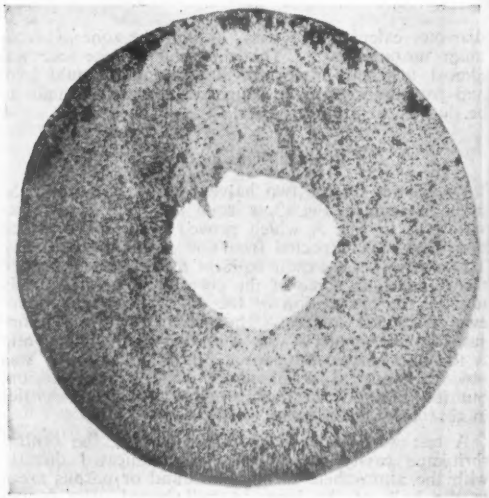


FIG. 5.—SULPHUR PRINT ACROSS THE SECTION. THIS REVEALS CONCENTRATIONS OF SULPHIDES ON THE TOP EDGE AND A "MUSHROOM-SHAPED" AREA LOW IN SULPHIDES. (APPROXIMATELY HALF ACTUAL SIZE.)

Residual Elements

A spectrographic search for residual elements was made and the results are given in Table VI. The iron was fairly free from residual elements, but it was surprising to find definite amounts of copper and tin present. The presence of vanadium and titanium in the amounts indicated is a common occurrence in old cast irons.

TABLE VI.—*Residual Elements by Spectrographic Analysis.*

	Per cent.
Nickel	<0.05
Chromium	<0.05
Vanadium	0.10
Titanium	0.12
Copper	0.08
Aluminium	0.10
Tin	0.09

Elements sought but not found:—Zirconium; zinc; rhodium; selenium; potassium; molybdenum; silver; platinum; mercury; berylium; tungsten; gold; cadmium; sodium; magnesium; lead; germanium; tellurium; calcium, and rare-earth elements.

Metallographic Examination

(*a*) *By macro-etching methods.*

The complete cross-section of the cannon ball was polished and macro-etched. Fig. 4 shows the structure which was revealed by this preparation. A very interesting "mushroom" configuration was revealed which appeared to suggest that the casting was indeed poured along the joint line from a runner which entered the casting at the area of roughness already commented upon. It is almost certain that the casting was top poured and that the runner acted also as a riser communicating with a feeder head. There was no indication, at least in the plane sectioned, of any other entry or exit for molten metal to the casting. The only minor spots of porosity were to be found at isolated points over the cross-section, the main porosity was in the central shrinkage cavity. There was no sign of a chilled edge to the ball.

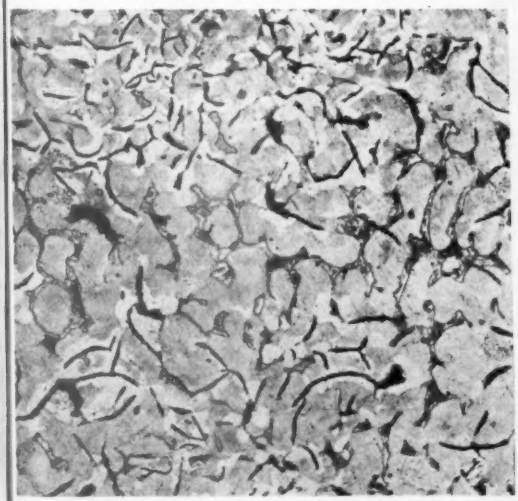


FIG. 6.—GENERAL MICROSTRUCTURE OF THE CANNON BALL. ×100.

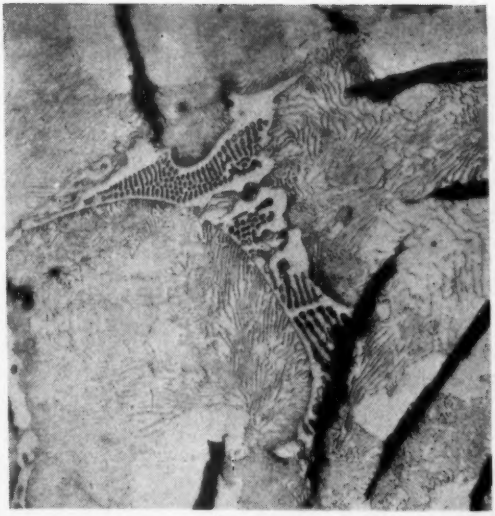


FIG. 7.—MICROSTRUCTURE ×600, SHOWING PEARLITE, FERRITE AND GRAPHITE.

(*b*) *By sulphur printing.*

The "mushroom" configuration was also revealed by sulphur printing, by which means it appeared as a low-sulphur zone. Fig. 5 shows also that sulphides had floated to the top of the mould-cavity, which indicated a fairly slow rate of solidification of the iron.

(*c*) *By micrographical examination.*

Fig. 6 shows, at 100 diameters, the microstructure of the cannon ball. The graphite was, in general, randomly distributed with some loose rosette configurations. The matrix was of pearlite and ferrite, with numerous areas of phosphides. The typical structure of the iron is also shown at a higher magnification in Fig. 7. Some of the graphite showed the presence of secondary graphite filaments attached to the primary flakes as in Fig. 8. The micro-structure was indeed typical of what would be expected from a modern iron of this composition.

Hardness Determinations

Firth diamond hardness tests were carried out over the complete cross section of the cannon ball. A few of the typical hardness values found are shown in

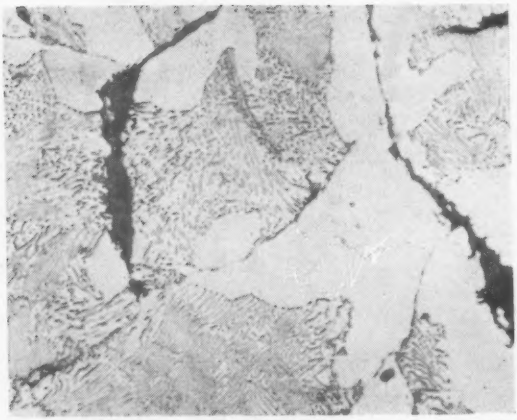


FIG. 8.—MICROSTRUCTURE ×600, SHOWING SECONDARY GRAPHITE.

Fig. 9. In the more solid iron near the surface of the ball the mean hardness value was approximately 160 Brinell. There was, however, no chilled layer at the surface. At points in the unsound zones near the mushroom configuration, hardness values much lower than the mean were recorded, due largely, it is suggested, to the sponginess at those points.

If the specimen examined was typical of the round shot used for missiles in the 17th century, one must regard quite highly the skill of the ironfounder of that day. The ball was well within tolerances of dimensional accuracy upon which it would be difficult to improve to-day. The shrinkage cavity, almost inevitable for a static sand casting of spherical shape, was normal and very centrally located.

The quality of the metal was good and in every way the equal of modern standards. In its comparative freedom from alloying elements (*i.e.*, nickel and chromium) it was typical of an ancient iron, but somewhat surprisingly it contained definite small percentages of tin and copper. Could this be due to an accidental or perhaps intentional addition of a small amount of bronze cannon to the molten iron before casting?

The Authors wish to thank the directors of the Staveley Iron and Chemical Company for permission to publish this Paper.

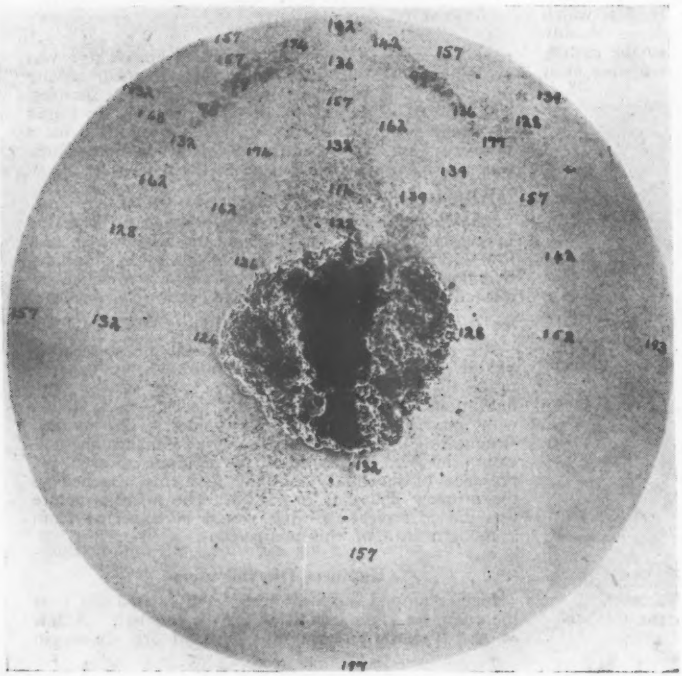


FIG 9.—DISTRIBUTION OF HARDNESS OVER THE CROSS-SECTION OF THE CANNON BALL (APPROXIMATELY FOUR-FIFTHS ACTUAL SIZE).

Metropolitan-Vickers Foundry

Development Over Thirty Years

Our representative recently had the opportunity of touring the foundries of Metropolitan-Vickers Electrical Company, Limited, in the company of the superintendent of foundries, Mr. A. Phillips, on one of the many visits organised in connection with the firm's Jubilee celebrations. As will be evident from the following

FIG. 1.—GENERAL VIEW OF FOUNDRY CENTRAL BAY.

FIG. 2.—CORE SHOP OPERATED BY FEMALE LABOUR. THE RADIANT-HEAT UNIT FOR BLACKING DRYING IS SHOWN ON THE LEFT.

Metropolitan-Vickers Foundry

dimensions, the foundry is one of the largest and certainly, in our opinion, one of the best equipped in this country.

The main building is 576 ft. long and 310 ft. wide, a total floor area of 178,560 sq. ft. It is divided into five bays, the centre one (Fig. 1) being 80 ft. wide, with a height of 55 ft. to the crane track. Two of these bays were lengthened to 776 ft. in 1920, and in one of these extensions the small and medium castings are "dressed." The castings produced in cast iron and an extensive range of non-ferrous materials vary in weight from a few ounces to 50 tons. Some further particulars, giving an idea of the magnitude of this plant are as follow:—

No. of overhead travelling cranes, 14. (Capacity from 1 to 50 tons.)
No. of jib cranes, 28.
No. of moulding machines, 70.
No. of cupolas, 9 (Size from 28 to 72 in.)
Total melting capacity, 45 tons per hour.
No. of drying ovens, 11.
Brassfoundry-melting facilities, 18 furnaces, 8 oil-fired and 10 coke-fired furnaces.)

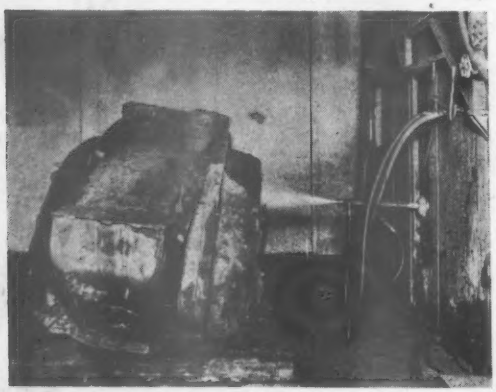


FIG. 3.—HYDROBLAST OPERATED FROM OUTSIDE THE CHAMBER.

Layout

The main building is divided into five bays and is laid out with wide and clearly-defined, straight-through gangways, covered with metal plates. The atmosphere is surprisingly clean, and a particularly pleasing and attractive appearance has been obtained by the intelligent use of light-coloured paints, shades of green, cream and aluminium being very well blended.

This policy of a clean and attractive foundry is not, in the opinion of the Metropolitan-Vickers management, to be an affair of the moment, as a plan for continuous re-conditioning and re-decoration of this foundry has been imposed. Wherever possible all the floors have been concreted, with the ultimate intention of having these sluiced down at the finish of the day's moulding operations.

FIG. 4.—SECTION OF THE FOUNDRY FOR THE SMALLER MOULDS WHICH ARE PRODUCED BY FEMALE LABOUR.

An outstanding piece of reorganisation is the girls' core shop, illustrated in Fig. 2, which is almost as clean as a model bakery, to which the girl core-makers themselves contribute to the decoration by bringing in bunches of flowers. There is one interesting gadget in this girls' core shop, which is likely to be helpful to others as it overcomes a very tiresome trouble. Sticky core sand is prepared in a Fordath mixer and is carried by belt conveyor to fill hoppers over the working benches. Although the first part of the belt is only slightly inclined, the oil-sand mixer persisted in balling-up. To overcome this, two rollers, the width of the belt, about 3 in. in diameter and studded with prongs, rotate at high speed and are arranged to break up the sand. These rollers are placed about 4 in. apart and the one nearest the discharge is suitably guarded against accidents to operators. A radiant-heat stove has been incorporated in the layout for drying cores after blacking; this is shown on the left of Fig. 2. The cores when made are fed on to a belt conveyor which terminates at a vertical continuous drying stove. After drying they are taken again by belt conveyor to the dressing and blacking stations and from these to the radiant heaters, already referred to, for final drying.

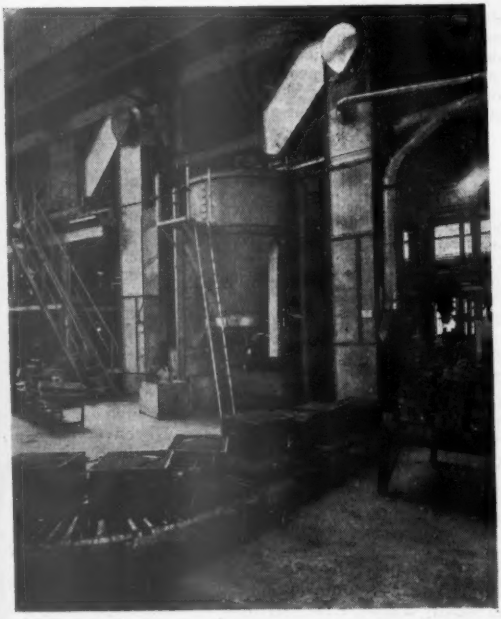


FIG. 5.—SAND PLANT FOR ONE OF THE MOULDING SYSTEMS. RIGHT—FUME EXTRACTION DEVICE AT THE KNOCK-OUT.

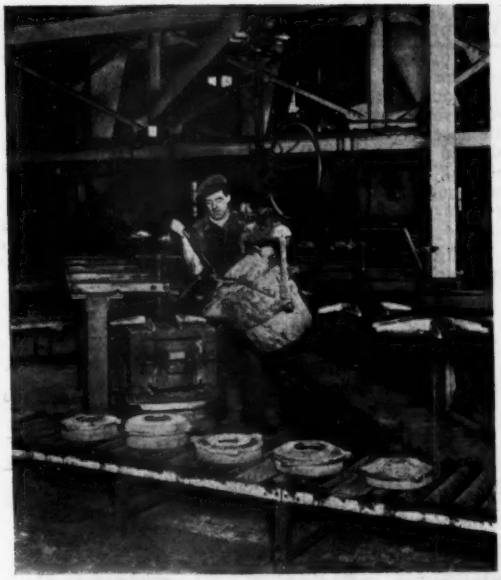


FIG. 6.—ARRANGEMENT FOR CLAMPING AND WEIGHTING A MOULD SO AS TO PREVENT FATIGUE.

Dust Elimination

It was very pleasing to see that the firm had made a most determined attack on the question of elimination of dust and the exhausting of all fumes at the knock-out points. It is a strict ruling with this company that no knock-out is handled unless a suitable fume exhaust plant is attached to it, and the management explained to us that it intends to extend the principle to floor moulding by using radial arm exhaust points. There are many others which lead to a clean and healthy atmosphere, such as the gas-drying of ladles and the entire elimination of open fires. The firm installed, over two years ago, a unit heating plant in the foundry which gives a uniform comfortable working temperature during the winter periods. The gas-drying of ladles is carried out by a rotatable gas-supply standard carrying at the end of a goose neck a powerful burner. The larger sizes of ladles are arranged in a circle around this burner, which has entirely eliminated the use of coke braziers. The mould stoves, too, have been modernised to incorporate a gas-fired re-circulating system which has almost completely eliminated the fine dust deposit from the previous methods of operation.

A large-size Hydroblast plant has been installed, which not only dustlessly strips castings but also enables core irons to be reclaimed complete, and it also reclaims sand for use in the moulding bays. The high

Metropolitan-Vickers Foundry

pressure hose, illustrated in Fig. 3, is usually operated from outside the chamber, as a rotating table is provided so that each face of the casting is presented to the hose for cleaning, as shown in Fig. 3. Where complicated coring is involved the operator enters the blasting chamber. This form of cleaning has had a profound effect on the dressing shop, which now with its concrete floor resembles a well-laid-out machine shop.

Whilst the firm has made the greatest amount of progress by the adoption of power-operated moulding

FIG. 7.—SPECIALISED UNIT FOR A HEAVILY-CORED MOULD; A FINISHED CASTING IS SHOWN IN THE FOREGROUND.

machines for the smaller castings, up to two or three cwts., it has made considerable progress on the larger castings by the adoption of more handling appliances in the form of overhead travelling cranes and by the intelligent use of Sandslingers and pneumatic rammers.

In the smaller semi-mechanised plant the 70 moulding machines used are divided into several units operating independently, as the firm claims that this obviates the necessity to shut down the whole plant in the case of breakdowns in one section. Power machines, both straight-draw and roll-over types of jolt-squeeze machines, have been installed, those producing the lightest type of castings being operated by girls, who, from our observations, were working at an extremely high rate. In fact, the whole appearance of this foundry suggested that the output per man-hour compared very favourably with the pre-war effort, and we were assured that in several directions the pre-war rates of output had been considerably exceeded.

Every possible consideration has been given to the relief from fatigue by the motion study of machines and handling operations. One existing example is given in Fig. 6 where the two half boxes are held down by screw jacks instead of by heavy weights which used to be lifted by the operator. Figs. 4, 5 and 6 show some views of the mechanised units, whilst Fig. 7 shows one specialised unit on several types of castings for electric motors.

Apprentice Training

The company fully recognises the importance of training apprentices, as is well illustrated in Fig. 8, where are shown boys in the early stages of tuition under the guidance of an expert skilled moulder. In addition, the apprentices are given instructions in a classroom closely adjacent to the foundry. Annual competitions are arranged for the best casting produced by an apprentice without any assistance.

Amenities

Four separate bath units have already been installed, consisting of shower baths, with clothes-changing cubicles and facilities for washing. One of these units is reserved for the use of apprentices. Here again the unit principle is being observed so as to economise in walking time. Instead of one huge centralised unit, the four units are distributed in various places about the foundry, so as to provide the greatest accessibility at all times during the working day.

In conclusion, we would like to pay tribute to the enthusiasm with which this particular foundry reorganisation has been carried out. Although we were very impressed with what had already been done, we were assured that only about one-third of the reorganisation has been carried out and that plans are in existence covering the next five years for further improvements in welfare for the workers and increased production. We were, for example, greatly impressed with the firm's plans to deal with one of the most difficult operations—the "dressing" of castings—and from what we saw we are confident that this dressing shop will be shortly a model for any firm to copy. Part of the dressing shop is shown in Fig. 9. Another impressive feature is the freedom with which the foundry is open to visitors. The district committees of two foundry trade unions have had visits to the foundry. It has also been visited by the Joint Advisory Committee on Con-

FIG. 8.—APPRENTICES AT WORK IN THE PRELIMINARY STAGES OF THEIR TRAINING.

ditions in Ironfoundries, and a large number of engineering firms have been received and been shown all aspects of this foundry reorganisation. Altogether we feel that this is one of the best post-war reorganisations we have seen and we were confidently assured on our visit of further improvements in the near future.

FIG. 9.—GROUPS OF FINISHED CASTINGS FROM THE "HEAVY" SECTION OF THE FOUNDRY.

New Blast Furnace Film

A new film entitled "Blast Furnace"—complementary to that on "Casting in Iron," which was recently reviewed in these columns—has been produced by Associated British Pathé, Limited. The film is a further unit in the comprehensive programme of films of an educational nature which the company is producing to give facts about industrial careers to children of school-leaving age. The subject-matter is produced in a non-technical manner, one which can easily be assimilated by children with the help of a printed commentary, or a limited amount of amplification by teachers. Each film is accompanied also by a film strip; eventually a sound track commentary will be added.

Both the film on "Casting in Iron," and the new one on the "Blast Furnace," which our representative was privileged to pre-view this week, have admirably achieved the aim of their producers. The latest film combines simple diagrams contiguously with shots of the actual blast-furnace operation at the Ford plant at Dagenham, and does so with dual success by bringing the drawings to life and relating views of portions of plant with the main conception of the integrated whole. This brings about a valuable combination of theory and practice rarely achieved in pictorial representation.

Both films have the approval of the education authorities and may well be used also for apprentice and student instruction. Details of their availability may be obtained direct from Associated British Pathé, at 133, Oxford Street, London, W.1, or, in the case of "Casting in Iron," from the Council of Ironfoundry Associations, 14, Pall Mall, London, S.W.1.

Classes in Metallurgy

The 1949-50 prospectus of the Sir John Cass Technical Institute, Aldgate, London, E.C.3, just received, contains details of day and evening classes in a wide variety of subjects. Those coming under the Department of Metallurgy cover the requirements in that field of the B.Sc. (Engineering) Metallurgy examinations of London University (internal or external); the City and Guilds of London Institute (including Foundry Practice); the preparation for the licentiateship and associateship of the Institution of Metallurgists, the examinations of the Royal Institute of Chemistry, and the Higher National Certificates.

In addition, there are specialised courses on the metallurgy of engineering metals and alloys, on construction of works, domestic and industrial fuel, and on the theory of the metallic state.

The autumn term commences on September 26, and full particulars regarding enrolment (which may be effected by post), fees, etc., can be obtained by application to the Principal.

MR. A. W. ROBSON, managing director of the Bradford Gas Engine Company, Limited, Shipley, died on Friday last at the age of 74.

National Foundry Craft Training Centre

A suitable house for use as a hostel for youths attending the National Foundry Craft Training Centre in West Bromwich has been purchased. It is conveniently close to the Centre, and is in pleasant surroundings. There are many advantages that the boys will derive from sharing in a communal life during the short residential courses, and firms at a distance from West Bromwich which propose to send their young workers to the National Centre can assure parents that careful provision for their sons' comfort and welfare will be made in the new premises.

A practical way in which founders generally can increase the usefulness of the Centre is to provide the trainees with different kinds of patterns and core boxes which can be used for exercises. Even quite intricate examples are welcomed. Ironfounders who possess any patterns or core boxes which they consider may be appropriate for this purpose are requested to send particulars to the National Foundry Craft Training Centre, at Rudge, Littley, Limited, Swan Village, West Bromwich.

Heating Appliance Testing in Scotland

New designs of solid-fuel-burning appliances are being tested in the Scottish headquarters of the Department of Scientific and Industrial Research at East Kilbride, with the object of getting the maximum heating value out of the fuel. This is the first research to be undertaken at the new town; it has been started at the request of the Scottish Fuel Efficiency Committee.

Tests are being carried out on cooking and heating appliances which would be required for a house normally occupied by a family of two adults and three children, and important data have already been obtained. Only a few scientists have been engaged on the initial work, but within a month it is expected that about 60 will be employed on this task, which was formerly carried out in England. The work involves the testing of different types of fuel with individual appliances to find the most economical fuel for any one particular unit.

Overseas Standards

It appears to be insufficiently well known that the British Standards Institution acts as the agent in the United Kingdom of all overseas national standards organisations. At the present time, when every possible avenue for export is being explored, many concerns write direct to standards organisations abroad, only to be referred to the Institution. Time and money will be saved by applying in the first instance to the British Standards Institution, 24-28, Victoria Street, London, S.W.1, for all information regarding standards, both home and overseas.

A System of Costing in a South African Steelfoundry*

By C. I. Rhind

Any Paper which is presented on costing will generally fall short of the ideals and rules of someone, be it the accountant or the technician. The Author wishes, therefore, that it be clearly understood at the outset that what follows is intended as a summary of the general methods in use by his particular firm, whose local conditions probably differ considerably from those of other concerns. If, however, anyone reading this Paper finds that it has been of assistance to him in any way at all, then the Author will have been amply rewarded.

Costing at its best, when applied to steel products, can never hope to be absolutely accurate in all respects, but any concern which has no system at all and merely compiles an annual balance sheet, etc., can hardly hope to make the best of its available resources in the face of modern competition. The main system used is process costing designed to cover the production of both rolled sections and steel castings, but the Author will confine himself to the section which concerns the foundry and the job costing relative thereto.

A Practical System

While some of the very large steel producers in South Africa use highly mechanised costing systems, the one under discussion is chiefly manual, supplemented by as many mechanical aids as seem reasonable so as not to make the system economically top-heavy. In order to minimise as far as possible errors of incorrect booking of time and materials, all sections of the plant and operations relative thereto have been given job symbol numbers. For example, a journeyman operating a moulding machine books his time to "14A" and should the machine require repairs, the fitter on the job would use "14B," "A" representing "Operation" and "B" "maintenance" of the machine. As this relates to a jobbing foundry, each order as accepted is typed daily, giving all necessary details as to customer, drawings, number off, price quoted, etc., and each order is given a consecutive number beginning with A1 to A999, B1, etc., to Z999, when the cycle is re-commenced, the same numbers being used for the job cost sheet relative to each order. Journeymen, apprentices and operators on direct production use these numbers on their daily time sheets.

At this stage it is necessary to explain that native labour is employed to a large extent in South Africa, but, as a class, these employees are not skilled artisans and usually are rated either as low-grade operators or as labourers, the distribution of their cost to the company presents a problem peculiar to this country. Each native employee receives a "ticket" for a day's labour and both his normal-time and overtime are charged to the operation concerned, and are distributed eventually to the job involved in the job-costing-system on the basis relative to that operation. This "ticket" system is of course a relic from methods used on the mines, and foundry owners are shortly to change it for the usual "clocking" system.

Values of Cost Ascertainment

The first aim of costing is to assemble in a form easily intelligible to both accounting and technical staff, the total result of each department in the foundry each month, divided by the total output of the foundry so as to give a "cost per ton" under each heading. As the financial year progresses, comparative data become available in the shortest possible space of time, marked differences being thrown up in the running of each section. Rising material- and labour-costs show up clearly, and incorrect allocations of larger items of time, stores, etc., are often found to give startling results. If these errors be not rectified at once, false impressions would be obtained which, if acted upon, would lead to losses through quotations being made on incorrect premises. Also, this monthly "cost per ton" comparison throws up departmental inefficiency and unnecessary expenditure which can be checked and rectified within a reasonable time. This, after all, is one of the main objects of costing.

Monthly Records

Melting is carried out in electric-arc furnaces, and this brings us to the first main cost sheet of "molten steel" (see Chart I). The main charge is scrap, which is supplemented by basic pig-iron and a small quantity of iron ore is used as an oxidant. These, added to handling, cutting and transport, give the total cost of the charge. Operational costs, including fluxing materials and alloys and maintenance costs, are then suitably sub-divided. Ladles, crane costs, and the total from the testing laboratory, form the next main sub-heads, and the small item of dolomite consumption is also shown. Provision is made for a specific reserve for extraordinary expenditure on machinery breakdowns and for furnace relining (at an agreed rate per ton of molten steel produced) and finally an accurate provision is made for all leave pay accrued in this department. It will be noticed that the item

*Contributed by the South African Branch and presented at the 46th Annual Meeting of the Institute of British Foundrymen.

Costing in South Africa

MOLTEN STEEL

PRODUCTION ACCOUNTS FOR THE.....MONTHS ENDED.....

	THIS MONTH*			
	Tons :	Amount :	Cost per ton :	
TO SCRAP USED				
Scrap				
Basic and Bessemer Pig Iron				
Iron Ore				
TO CUTTING & HANDLING & TRANSPORT TO FURNACE				
TOTAL COST OF CHARGE				
TO OPERATING OF ELECTRIC FURNACE				
Operating Charges, Wages, etc.				
Graphite Electrodes				
Fluxing Materials				
Sundry Ferro-Alloys				
Electric Power				
TO MAINTENANCE OF ELECTRIC FURNACE				
Electric Equipment				
Refractory Materials				
Machinery				
Maintenance, Sundry				
Electric Generating Plant				
LADLES				
DOLOMITE CRUSHING				
MELTING-SHOP CRANES				
LABORATORY				
WORKS GENERAL EXPENSES				
MAINTENANCE RESERVE				
LEAVE PAY RESERVE				
LESS—Loss in Treatment				
Spillage				
COST OF MOLTEN STEEL POURED				

* These three columns are twice repeated, but carry as the main caption "LAST MONTH" and "YEAR to DATE"

CHART I.—MOLTEN STEEL COST SHEET.

"works general expenses" has been included. This relates to all sundry expenditure (such as office administration, etc.) which is not directly connected with any particular department, and is re-distributed on a basis of direct labour costs, molten steel bearing its proportion. Losses of weight in treatment and spillage are non-recoverable, being deducted from the total charge to give the net weight of molten steel produced.

Chart II indicates the method adopted to re-allocate the total molten steel costs over the three types of steel produced, *i.e.*, ingot steels; straight carbon steels for castings and 12 to 14 per cent. manganese alloy steels, also for castings. The quantity of ordinary ferro-manganese (70 to 72 per cent Mn) used for manganese steel is carefully weighed and charged to this steel. The balance issued during the month being allocated on a tonnage basis to ingot and straight carbon steels. Occasionally it is necessary to use special low-carbon ferro-manganese, and this is charged direct to manganese steel. Subtracting these alloy charges from total "molten steel cost" gives what is designated "first cost." The charge and proportionate handling relative to manganese steel is calculated and deducted from the total "cost of charge," giving the "cost of charge" for other steels. All other costs which are termed "balance of account," *i.e.*, "first cost" less "cost of charge," are then split between "manganese" and "other steels" on a percentage basis related to production as shown at the bottom of Chart II. This then gives the exact "first cost of manganese steel," the first cost for other steels being split in proportion to production. After cross casting, an exact total is obtained which agrees with the main molten steel account.

Chart III shows how the cost of molten steel is then transferred totally to "steel castings account." On this account are then reflected, in detail, the actual assembled costs of the various operations in the foundry, including pattern-making. The last items of cost require some explanation. Supervision represents the salaries paid to non-working foremen and chargehands; "works general expenses" and "leave pay reserve" are the same as under "molten steel"; "general maintenance" is the assembled cost of maintaining the building and foundry offices, and "electric power" is the total unit cost allocated to the foundry. All headers, risers, wasters and replacements are carefully weighed and credited back at the price per ton at which scrap is costed to "molten steel." A six per cent. irrecoverable loss ("unaccounted for loss") is then made in weight only, which percentage is arrived at from experience, but which may be altered should variations be found after bi-annual physical stocktaking. The cost of castings poured is then available, which, divided by the net weight of good castings produced, gives the final cost per ton in the foundry.

Machining costs are taken in at the "trading account" stage, and all cost sheets form an integral part of the main accounts system, which is finalised each and every month, a full balance sheet, accounts and report being presented. Being satisfied that all figures for the month have balanced, one is then in a position to proceed with the statistical arrangement of information required for job costing.

Job Costing

Chart IV is the direct labour sheet on which is entered, daily, from time sheets, the exact hours worked by each individual employee on the direct production of castings, normal time and overtime being segregated. When the job is complete, the hours are totalled and converted at the rate payable to each man, direct labour costs being thus obtained. Workshop hours (blacksmiths and fitters) are converted at the ruling shop hourly rate which is available from the main monthly re-distribution sheets.

The costs from Chart IV are then transferred to the "direct labour" column on Chart V. This is the final job cost sheet, which on completion is filed in

"job order-number" and is available to all senior executives and estimators to use for future pricing and estimating. In order to obtain the information required for the "other costs," column, all direct labour is extracted by the time office and then subtracted from the total of each operation in the foundry, and at the same time the total of "production" hours of moulders and core-makers, and pattern-makers are obtained, the monthly tonnage produced being already available. Rates for "other costs" on pattern-making, moulding and core-making, and machine-moulding are on the direct per-hour production rate; all others being on a per-ton basis of total monthly output. "Molten steel" is on a per-ton basis of the molten steel costs for straight carbon or manganese steel, the exact quantity of each, to make up the total produced for the month, being available. (This is done by keeping records both of steel taken and headers, etc., separately for each kind of steel.) It is obvious that "annealing" relates to straight carbon and "heat-treatment" to manganese steel.

Monthly Overlap

As it is not possible to regulate the production of each job so that it shall be started and completed in the same month, the Author uses for job costing the average rates applicable to the three months immediately prior to the month in which the job is completed. This raises the controversy that job costing should be completely "tied up" with the main financial accounts. The conclusion has been reached, however, that the results which obtained are highly satisfactory for the foundry concerned and that the system is a benefit and not a financial burden to the company.

All other details not mentioned, but which are relative to the final job cost sheet, it is felt are self-explanatory and need not be laboured in a paper of this nature. Throughout the Paper, the Author has avoided quoting figures, first, because the short ton of 2,000 lb. is used and, secondly, because it is felt that, when reading a paper, the main issue which is the "system" is apt to become fogged by a conglomoration of figures.

In conclusion, the Author would like to take this opportunity of thanking the South African Branch of the Institute of British Foundrymen for asking him to contribute this Paper. It may fall short of more elaborate systems, but he hopes that it has been of benefit to the members.

DISCUSSION

THE CHAIRMAN (Mr. R. B. Templeton) said that they were indebted to Mr. S. H. Russell for his explanation of the Paper. It was a good attempt to adapt a costing

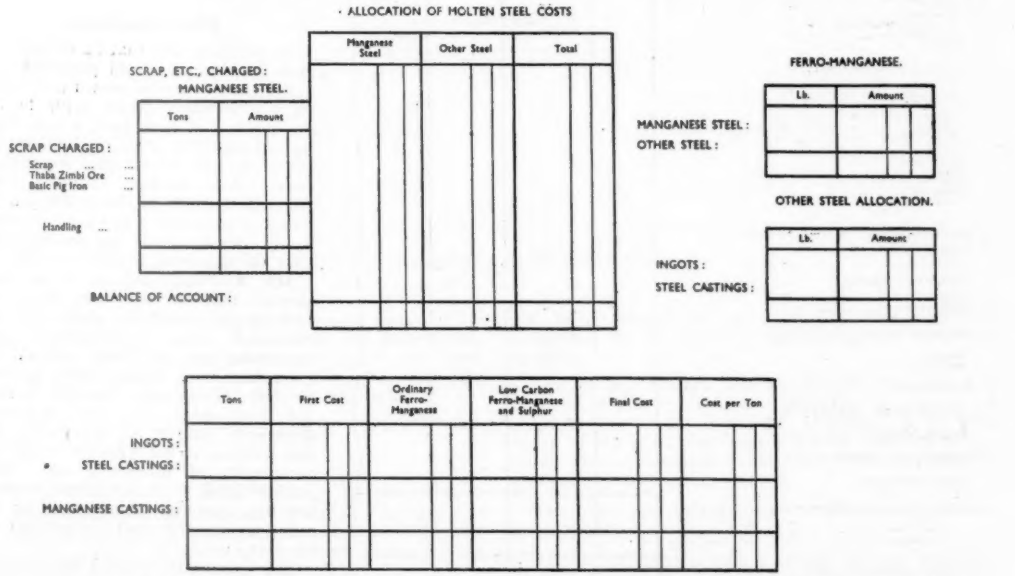


CHART II.—RE-ALLOCATION OF MOLTEN STEEL COST ACCORDING TO TYPE.

Costing in South Africa

STEEL CASTINGS.

PRODUCTION ACCOUNT FOR THE..... MONTHS ENDED... ...

	THIS MONTH*			
	Tons	Amount	Per Ton	Tons
To COST OF MOLTEN STEEL USED:				
For Other Steel Castings				
For Manganese Steel Castings				
TOTAL STEEL USED:				
To PATTERN SHOP COSTS:				
MOULDING AND COREMAKING:				
Sand Used				
Other Costs				
MOULDING MACHINES:				
Operation and Maintenance				
Sand Spent				
SAND MIXER:				
Operation				
Maintenance...				
BOX PARTS:				
New Boxes				
Maintenance...				
DRYING OVENS:				
Operation				
Maintenance...				
Coal and Coke Used				
SAND BLAST PLANT:				
Operation				
Maintenance...				
Operation and Maintenance of Driving Compressor				
Shot Used				
ELECTRIC WELDING PLANT:				
FETTLING:				
Oxygen				
Operation				
Maintenance...				
GRINDING:				
Operation				
Maintenance...				
New Grinding Wheels				
MANGANESE HEAT TREATING FURNACE:				
Operation				
Maintenance...				
ANNEALING FURNACE:				
Operation				
Maintenance...				
FOUNDRY CRANES:				
Operation				
Maintenance...				
SUPERVISION:				
GENERAL WORKS EXPENSES:				
ELECTRIC POWER:				
GENERAL MAINTENANCE:				
LEAVE PAY RESERVE:				
LESS—Risers Recovered and Returned to Scrap				
Wasters				
Replacements				
Unaccounted-for Loss				
COST OF CASTINGS POURED:				

* These three columns are twice repeated, but carry as the main caption "LAST MONTH" and "YEAR to DATE"

CHART III.— ACCOUNT FOR STEEL CASTINGS, SHOWING ASSEMBLED OPERATIONAL COSTS.

system to the requirements of a particular foundry and in discussing the Paper they must look at it from that angle.

A MEMBER said he agreed it was a great pity that the Author had not given them any details of the type of casting he was producing. He thought he must be producing ingots. He did not think that for the average jobbing foundry there was anything more misleading than the final results. That was a pity because in his opinion it was a good Paper.

MR. S. H. RUSSELL said that he, too, agreed that it was dangerous to average all these factors. He was convinced that the Author had, in fact, carried out his costings by averaging. He thought that he must have been dealing with a uniform product otherwise, he would have been misleading himself and there would have been serious risk of considerable errors occurring if he was costing a wide variety of castings on this average method.

Prior Assessment

A MEMBER said that he did not see how the Author could possibly have arrived at the results shown in Chart 3 on a reasonable figure prior to the operation. If they took a job from an outside firm, they worked on the actual cost in labour plus overheads. How the Author could have assessed it prior to doing the job he failed to see. He could not see what would be the costs beforehand and offer the customer a definite price.

MR. RUSSELL said he could only assume that it had been done by striking an average, and that he estimated the core-making and machining time on direct labour, all the other items being shown at cost per ton. He thought that the Author got fairly near, but there was undoubtedly danger in estimating by this method if the product varied in complexity of moulding, etc. The Author filled in his estimated productive time and the other figures on an estimate per ton and so arrived at his cost.

THE CHAIRMAN pointed out that on Chart 1 the Author had an item "Works General Expenses," and asked whether that would include all his miscellaneous stores?

Order No. Customer Ordered
Description Completed
Weight

		Totals.	Rate.	£ s. d.
Moulders				
Cores				
Pattern-makers				
Blacksmiths				
Fitters				
OVERTIME.				
Moulders				
Cores				

CHART IV.—DIRECT LABOUR COST SHEET.

MR. RUSSELL said that the item would relate to all office expenditure but not to a particular department. The Author had assembled his overheads and said "My total labour is x number of pounds and this is y," and he allocated it to his direct labour.

THE CHAIRMAN said that he had in mind materials rather than labour.

Overtime

MR. WILLIAMS said that on Chart IV. he was not clear why the Author separated overtime. It was usual to include the overtime increment in the general overheads.

MR. RUSSELL said that this also puzzled him. It seemed rather an old fashioned method. It might be that the South African standard of book-keeping was not so meticulous in operation, and that they had simplified the operation by minimising the risk of a mistake.

MR. F. N. WRIGHT said he thought that this had been done mainly because a considerable amount of overtime had been spent on a particular job and some of the costs had been allocated back on a time basis. There appeared to be some confusion between costing and estimating.

THE CHAIRMAN said that he thought that was a very good point.

MR. K. MARSHALL said it seemed to him that they knew too little about the type of casting and the type of production. He was against the complete throwing out of the cost per ton. It was a useful check. He thought that they must assume that the average weigh:

Costing in South Africa

Order No.	Estimate No.	Date of Order
Customer		Date completed
Description		Weight
(1)		,,
(2)		,,
(3)		,,
Annealed/Manganese Steel.		Total weight

		Direct labour.	Other costs. Rate.	Other costs. Amount.	Totals.
PATTERN SHOP					
Pattern-makers	.. Hrs.				
STEELFOUNDRY					
Core-making	.. ,,				
Moulding—Hand	.. ,,				
,, ,, —Apprentices ..	.. ,,				
,, —Power machines ..	.. ,,				
Electric welding	at per ton				
Fettling	,,				
Electric power	,,				
Box parts	,,				
Drying stoves	,,				
5 and 10-ton cranes	,,				
Annealing	,,				
Mn. heat-treatment	,,				
Sand blast plant	,,				
Grinding	,,				
Handling and despatching ..	,,				
General maintenance	,,				
Supervision	,,				
Core irons	at per lb.				
WORKS OFFICE EXPENSES ..	at per ton				
MOLTEN STEEL	,,				
TOTAL CASTINGS COST					
CASTING COST PER LB.	Pence				£
MACHINING					
1. Own machine shops	.. Hrs.				
2. Outside shops	.. Cost				
3. Blacksmith shop	Hrs. at				
Machined by					
BOUGHT OUT MATERIALS					
TOTAL WORKS COST					£

Examined..... .....Works Manager.

CHART V.—FINAL JOB COST SHEET.

of the castings was reasonably uniform otherwise the cost per ton in a jobbing foundry would be meaningless. Referring to job costing, his own experience had been limited to forgings. There the disparity in the costs was frequently considerable. One of the nightmares was tracing back rejects up to 12 months afterwards. Too many people seemed to confuse job costing with estimating.

MR. RUSSELL said that no doubt extra time would have been booked for making the replacements.

MR. MARSHALL replied that what he had in mind were customers' rejects.

"Pop-ups"

By "Tramp"

Many castings produced in the grey-iron foundry are prone to slight defects on the top surface, especially if the mould cavity is such that gas pockets are formed. In such cases the natural permeability of the sand is not sufficient to allow the rapid escape of the gas and good castings are only produced by the aid of "pop-ups." These are small holes made in the top box by the aid of a large vent wire or a moulder's cleaner, and which become cavities into which the entrapped gases can rush. One application is sketched in Fig. 1, which shows the deep top rim of a light belt pulley cast in a green-sand mould, the joint of the mould being at XX. If the pattern had been so constructed that the joint was at YY, there would be no need for "pop-ups," as the mould joint would provide sufficient vent for the entrapped gas.

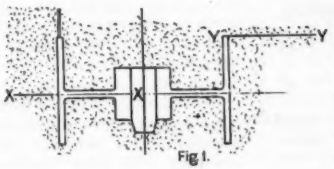


Fig. 1.

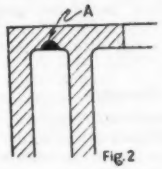


Fig. 2

Some cases occur, however, when "pop-ups" may be a disadvantage rather than an advantage. One example concerned a small complicated casting formed entirely by cores. The top surface was flat and made off the pattern, but this was often turning out "airy." The suggestion was made that the gas generated during casting could not escape freely, and thus a "pop-up" was advisable. This was not the correct solution of the problem, as, although ensuring a clean top face, a new defect occurred on the top of one of the cores, as at A, Fig. 2, very similar to a pellet in the iron. This was immediately under a "pop-up," and the gas from the core had been bubbling off from the top of this core through the metal, but as the job solidified, the last bubbles created were trapped, causing the defect described.

The cure for this defect was not the use of a "pop-up," which would encourage the gas from the core to escape by this means, but rather the making sure that the vents from the various cores were free and correctly connected.

Pinholing in Brass Castings

The presence of pinholes showing up during polishing of brass castings is frequently the result of several unfavourable circumstances; they can be cured by a number of remedies, the reliability of which, in each particular case, can only be established after experiment. One of the major causes is casting at too high a temperature. Therefore, the first step to be taken is to reduce the casting temperature as far as the nature of the casting will allow. To make the same castings at a lower temperature, one can add, using discretion, a little phosphor-copper, which, whilst deoxidising the bath, will give it increased fluidity. Phosphor-copper additions cannot invariably be undertaken without trouble, as they are liable to give an inferior surface to the casting. They can, moreover, themselves introduce unsoundness. Therefore, it is recommended that initial trials should be with amounts not exceeding 0.1 per cent. The addition should be made in the ladle, and the alloy should be allowed to stand for a full minute. Then the slag should be raked off before pouring the metal into the moulds.

To a certain extent, the defect can be caused by the nature of the fuel oil used for melting. If this be the case, the use of a flux containing 50 to 60 per cent. of anhydrous carbonate of soda with 30 to 40 per cent. of borax or powdered glass should bring about an improvement. The quantity of flux to use should be such as to provide a bath covering of 0.4 to 0.8 in. thick. It is also recommended that to avoid the defect under consideration it is advantageous to have the moulds very permeable to gas. Generous venting is always necessary for the production of sound castings. Nevertheless, all normal precautions against the presence of gas in the metal during solidification should be taken; special precautions are:—Rapid melting using a neutral or slightly oxidising flame, but never a reducing one; that is to say, the flame must be neither red nor fuming. Under no circumstances must the metal be allowed to "stew," not even for one minute after the metal is ready for casting, for it is at this time that it is the most susceptible to gas absorption. The mould should be prepared well in advance. Finally, it is essential to exclude moisture in all forms and, especially, the use of very dry ladles is called for, together with avoidance of high moisture in the moulding sands. The above information is taken from the Bulletin of the *Centre Technique*.

National Insurance Schemes and Law Actions

By F. J. Tebbutt

The ending of the Workmen's Compensation Acts, with the bringing into force of the National Insurance schemes, has necessitated another outlook as regards compensation and damages in actions at common law in relation to personal injuries, and this applies to injuries whether sustained at work or anywhere—from motor collisions, road accidents, accidents generally. So it is that a new Act now operates to meet these matters—the Law Reform (Personal Injuries) Act, 1948.

Assessment of Damages

By the Workmen's Compensation Acts, an injured employee could either take compensation under those Acts, or try for damages by an action at common law (by which means it was thought that more compensation would accrue), but he could not receive damages by both methods; thus the term "alternative remedies" became an official term for these matters. Common law actions, however, are open to everyone, whether the injury be at work or otherwise. With the National Insurance Schemes now operative, practically everyone has available certain benefits under those Acts (even the self-employed, employers, and so on, are eligible for sickness benefits), and so the question of damages for personal injuries has required attention. The position was (until the Act under review) that it was possible to get two compensation payments in connection with the same injury, through the courts and through the insurance schemes.

By this new Act, the position has been dealt with so that, while the whole sum of the National Insurance benefits is not to apply, the court now is bound to take into account in assessing damages in common law actions for personal injury, one-half of anything which may be receivable for industrial injury benefit, industrial disablement benefit or sickness benefit under the insurance schemes, during the five years beginning with the time when the cause of action arose. This will almost surely mean that the person called upon to pay damages will not have to find so much cash as formerly, that is, to the extent of the benefits to be taken into account, the sum of these being received by the injured person through the schemes and not from the person called upon to pay damages under a common law case.

Common Employment

Another matter dealt with in this Act is the legal doctrine of "common employment." Until the advent of this measure under review, if a wrongful act of an employee had caused injury to another employee, an employer could not be required to pay damages in such circumstances, this doctrine arising from a legal decision given as long ago as 1837. In this case, "*Priestley* v. *Fowler*," it was held that an employee who had been injured by the overloading of a van by a fellow employee could not maintain an action against the employer.

This new Act now ends all this, as the Act specifically states that it shall not be a defence to an employer who is sued in respect of personal injuries caused by the negligence of a person employed by him, that that person was at the time the injuries were caused in common employment with the person injured. Furthermore, there can be no "contracting out" from this provision by any agreement between an employer and employee. The Act lays down that any provision which would remove the liability of an employer in such circumstances inserted in a contract of service or apprenticeship shall be void, and this applies whether the contract was entered into before or after the commencement of this 1948 Act.

Computation of Damages

As regards the computation of damages in common law actions for personal injuries, a court would doubtless take into consideration various matters, such as probable loss of earnings or profits, attributable to the injuries, an amount for pain and suffering, and so forth. It is not required to publish these details, and can do so or not according to its inclination; only the lump sum awarded need be mentioned in the judgment. Similar discretion is given in this Act as regards the National Insurance Benefits; these must be taken into account, but the Act shows that there is no necessity to show the amount of damages before and after taking these into account.

British Standards Institution

The recently issued British Standards Institution Monthly Information Sheet for July lists the following of interest to foundrymen:—

Under "New Standards Issued" there are: B.S.1563: 1949 cast-iron sectional tanks (rectangular) (5s.), and 1571:1949 acceptance tests for positive-displacement compressors and exhausters (2s. 6d.). Under "Amendment Slips Issued" there is: PD 917 amendment No. 1 to B.S. 1251:1945 open fires for domestic purposes. "New Work Started" includes screen analysis of coke, and chilled shot and grit.

Among "Draft Standards Circulated for Comment" there are: CK 4361 pneumatic tools and accessories (revision B.S. 673), and CK 4385 industrial safety-gloves.

Pig-iron Working Stocks Increased

As a result of representations made to the Iron and Steel Division of the Ministry of Supply by the Council of Ironfoundry Associations on the subject of working stocks of pig-iron, the Division has agreed to an increase. In future, a stock equivalent to six weeks' consumption instead of three will be arranged. This concession has been made possible by the relatively easier position of pig-iron supplies, and it is promised that the situation will be kept under review.

Experiences with Ethyl Silicate in the Foundry*

Survey of Potential Applications

By D. F. B. Tedds†

Summary

During the past eight to ten years the organic silicate materials have received much prominence as being materials suitable for bonding refractory bodies together, and this Paper describes the usefulness of one of them —ethyl silicate. A brief outline of the precision investment casting process is discussed, and some of the defects encountered during moulding are enumerated. The use of ethyl silicate for such ancillary applications as furnace linings, refractory shapes, washes, *etc.*, is given. Finally, a method of core making is suggested, which has a limited scope for small- or medium-sized cores, its greatest advantage being that it eliminates the use of compounds, which generate large quantities of gas. It is concluded that ethyl silicate can be used to advantage for certain applications in the foundry.

Introduction

The earliest application of the silicon esters of which ethyl silicate is one) was for the preservation of artistic and architectural stone work. Later it was used for bonding together refractory bodies in the form of a paint; then, just before the second world war, it was used for making refractory shapes and moulds. The reason it finds its usefulness in these applications is that, after certain chemical reactions have taken place, silica is deposited, the liquid turns to a jelly-like mass, and sets hard in a comparatively short time.

Production of Ethyl Silicate.—Ethyl silicate is made by first passing chlorine over heated metallic silicon to produce a yellow fuming liquid called silicon tetrachloride. This is then reacted with industrial methylated spirits (ethyl alcohol) to form the silicon-ester or ethyl-silicate, according to the chemical equation:—

$$SiCl_4 + 4C_2H_5OH = 4HCl + Si(OC_2H_5)_4$$

Silicon Tetrachloride.	Ethyl Alcohol.	Hydrochloric Acid.	Tetra Ethoxy Silicaine (ethyl silicate)

Hydrolysis.—In order to obtain a binder or jelly-like mass, the ethyl-silicate must be hydrolised, that is, it must be given water. The two react to produce silicic acid, which, when heated, produces silica, thus:—

$$Si(OC_2H_5)_4 + 4H_2O = Si(OH)_4 + 4C_2H_5OH$$

Ethyl Silicate.	Water.	Silicic Acid.	Alcohol. Ethyl

Heat

SiO_2

The hydrolysis of ethyl silicate in a neutral solution is rather slow. In the presence of alkaline materials the reaction proceeds very rapidly, forming a gelatinous precipitate. In the presence of mineral acids the hydrolysis is less rapid and more easily controlled. Full use is made of these phenomena during various stages of the process outlined in this Paper. For example, it is common practice to acidify with hydrochloric acid the water used in the initial stage of the hydrolysis, and then to obtain the silica in a gelatinous form by neutralising the acid with magnesium oxide mixed with the refractory material.

Care must be taken at all stages of the technique, as too much acid will reduce the " shelf life," since the higher the concentration of acid employed, then the shorter will be the time required for hydrolysis. Also, the magnesium or alkali content in the refractory must be carefully controlled, so that it will neutralise the acid and produce gelation in the correct time period.

There are usually three stages in the procedure for hydrolysing the silicon ester:—(1) Initial hydrolysis; (2) dilution, and (3) cooling; and the final result can be:—(*a*) a water solution, or (*b*) a spirit solution. Details of the composition of the solutions used at various stages of the different techniques, described later, are given in the appendix. The solutions described are those used for all work in this Paper, and are offered as typical examples, since it is known that varying ratios of ethyl silicate to alcohol and water and other methods of hydrolysis would probably work equally well.

Precision Investment Casting

Ethyl silicate found great prominence with the advent of precision investment casting during the early 1930's. It was soon realised that here was a material capable of bonding suitable refractory aggregates into which steel and the high-melting-point metals might be cast. Much has been written about this process during recent years and this must be familiar to all and, therefore, it is not proposed to go into great detail with the technique as a whole, but to give a brief outline with particular emphasis on the moulding technique and moulding treatment.

After receipt of the master pattern of the component to be cast, a soft metal die is produced into which molten wax is injected under pressure. An alternative to this process is the production of a conventional machined die in which the wax patterns are made. The wax models or patterns are then assembled into casting formation on to a common runner, and given a primary refractory coating by spraying or dipping. When this has dried, the complete assembly is attached to a base-

*Presented at the Cheltenham Conference of the Institute of British Foundrymen.

†The Author is foundry metallurgist, The Bristol Aeroplane Company, Limited.

Ethyl Silicate in the Foundry

plate, and the moulding box is slipped over the top (and also attached to the plate) ready to receive the investment or moulding material.

Pattern Investment

The refractory is best compounded from materials having no free silica (owing to the risk of silicosis), *e.g.*, the aluminium silicates, the most well known being sillimanite. This can be obtained in various grades which can be mixed to give coarse, open, friable mixtures, or very dense, close, hard mixtures. Whatever mixture be used, a certain percentage of an alkali is added to act as an accelerator, as explained earlier. A recommended mixture, and one that has been found quite suitable for the production of precision castings cast under pressure, is as follows:—80 lb. of medium-grade Sillimanite; 20 lb. of fine-grade Sillimanite, and ½ oz. of magnesium oxide. The sieve analysis of this mixture is given in Table I:—

TABLE I.—*Sieve Analysis of a Refractory Mixture for Precision Investment Casting.*

Percentage retained on B.S. Sieve No. 16						..	..	Nil
,,	,,	,,	,,	,,	,, 22	..	..	Nil
,,	,,	,,	,,	,,	,, 36	..	..	9.40
,,	,,	,,	,,	,,	,, 44	..	..	8.70
,,	,,	,,	,,	,,	,, 60	..	..	11.61
,,	,,	,,	,,	,,	,, 100	..	..	12.55
,,	,,	,,	,,	,,	,, 150	..	..	11.31
,,	,,	,,	,,	,,	,, 200	..	..	10.95
,,	,,	,,	,,	,,	,, 300	..	..	10.80
Percentage passing through B.S. Sieve No. 300						..	..	24.68

To each 1 lb. of the above sand is added 200 ml. of spirit solution "B."* This mixture, when thoroughly mixed, is in the form of a sludge or slurry, and is poured into the moulding flask, where it flows quietly around the wax assembly. It is then consolidated around the assembly by vibrating the whole on a mechanical, pneumatic or electrical vibrator for one to two hours, depending upon the diameter and the height of mould desired. The excess bonding solution rises to the top of the mould and is poured off and used again and, later, the moulding plate is stripped from the box and mould. About one hour after vibration a considerable hardening will have taken place, parallel with the production of silicic acid in the mould as the hydrolysis becomes complete.

Should the moulding technique be incorrectly conducted, then certain defects may manifest themselves within the mould. The most prevalent defect is undoubtedly the occurrence mould cracks which produce flash or fissures on the resultant castings, subsequently to be removed by fettling. These cracks can be produced or accentuated by:—(1) Incorrect grading of the sand aggregates. Too high a percentage of fines (passing 200 mesh) causes excessive shrinkage to occur when the mould is dried and fired. (2) Insufficient amplitude on the vibrating table. A vibrating table which has insufficient amplitude will not settle or pack the sand particles sufficiently. The mould then contains an excess of bonding solution which, after the hydrolysis is complete, shrinks excessively on drying, setting up stresses and so producing cracks. (3) Excessive amount of alkali present in the sand mixture. Should an excessive amount of alkali be present in the sand mixture, then the "setting time" is advanced, causing gelation of the silicic acid to occur before the packing or consolidation of the refractory grains around the wax pattern is complete. This means that the mould has hardened with an excess of solution present, and should vibrating be continued, then ruptures will occur throughout the mass.

If the primary coating on the wax assembly is not allowed to air dry sufficiently, poor chemical adhesion is obtained between the main body of the mould and the primary coating. Upon heating the mould, the primary coating cracks and flakes away, the resultant casting having a scabby surface.

Drying and Firing

After sufficient time has elapsed, the moulds are placed in a forced-circulation air-oven, the temperature of which is controlled to plus or minus 5 deg. C., and held for 6 hrs. at 45 deg. C., followed by 6 hrs. at 140 to 150 deg. C. The initial low-temperature period hardens the moulds and drives off a certain amount of alcohol, whilst the high temperature melts out the wax pattern and dries and hardens the mould still further. The moulds are then transferred to the high-temperature furnace. This is usually a tunnel type of furnace with a progressively increasing temperature from the charging door to the high-temperature zone. On entering the furnace the moulds are gradually traversed along, the residual wax and alcohol which remains in the mould burning out as they reach a temperature of 1,000 deg. C. The moulds are then ready to receive the molten metal.

The metal is melted in an electric furnace of the indirect-arc type fitted with an arrangement for air pressure to be introduced at 5 to 15 lb. per sq. in. As soon as the metal is at the correct temperature for pouring, an asbestos gasket is placed around the tap-hole of the furnace and the mould is removed from the high-temperature oven to be clamped thereto. The furnace is turned through 180 deg. and the metal is forced by gravity and pressure into the mould cavity.

It might be added that, should the mould be insufficiently fired in the high-temperature oven, then the face of the mould cavity will be coated with unburned wax and soot, which reacts with the molten metal as it enters the mould with disastrous effects on the resultant casting.

As soon as the mould has cooled to room temperature, the casting is stripped, the runners are removed by a high-speed abrasive wheel and the castings shot-blasted. They are then submitted to 100 per cent. X-ray, visual and dimensional inspection, before leaving the foundry.

MOULD AND CORE DRESSINGS, FURNACE WASHES, ETC.

The purpose of a mould or core dressing is to give protection against the action of liquid metal and help to produce a smooth, clean skin on the casting. Using

* See Appendix.

both the spirit solution "B" and the water solution "A" cores have been coated successfully and both aluminium and magnesium castings have been produced using such cores.

The application of the spirit solution over the surface of a dried or baked core considerably hardens the top layer and produces a non-friable surface without affecting the characteristics of the core mixture with regard to ease of knock-out, *etc.* The dried cores are painted with the spirit solution, which is then lighted to burn off excess alcohol. When cooled, the core is ready for assembly into the mould. A good cast skin is produced on the castings, according to the surface of the original core and the ethyl silicate which helps it to resist metal-wash as the metal flows over it.

If a refractory coating is desired, the water solution offers the best method, since the gel produced is not so hard as that obtained from the spirit "A" mixture and is more flexible. Upon drying, this gives a coating which is less prone to "crazing" when the refractory filler is added. The most satisfactory filler depends upon the metal being cast, but silica flour, alumina, sillimanite, and zirconia (all to pass a 200-mesh sieve) have been successfully bonded and sprayed over cores both before and after drying.

The spraying of moulds with the water solution "A," prior to skin drying, offers possibilities. The most important application to date was carried out on moulds into which magnesium was to be poured. The moulding sand consisted of a washed silica sand with 4 per cent. Fulbond and 2 per cent. ammonium bifluoride. Normally, skin drying of such a mould produces a friable surface easily erroded by the stream of molten metal. After spraying the surface with the water solution and then skin drying to a depth of ¼ to ½ in., an excellent and hard surface was produced which resisted erosion successfully.

Application to Oven Walls

Applying refractory washes to the inside of high-temperature ovens is common practice in order to protect the brickwork. A satisfactory application has been tried on a tunnel-type oven operating at 1,000 deg. C. This was coated with alumina bonded with the spirit solution "B." The inside surface of the furnace is still quite satisfactory after 18 months' continuous use.

FURNACE LININGS AND REFRACTORY SHAPES

A further application for ethyl silicate can be found in the making of furnace linings, crucibles, *etc.* Where high temperatures are encountered, as for example in the melting of steel, then the high-grade refractories required to withstand these conditions can be successfully bonded with ethyl silicate to give a hard refractory shape, or lining, capable of withstanding the severest of conditions. An example which illustrates this is the production of a crucible and lining for a 10-lb. capacity indirect-arc furnace used for high-melting-point alloys in the precision-casting process.

A crucible of approximately 1-in. section is first made in two halves (Fig. 1). A sheet-metal jig is used to form the outside shape, and a wooden former is placed inside for making the spherical inner shape (Fig. 2). Both are smeared with Vaseline. Alumina refractory is then mixed with spirit solution "C" and poured into the jig, where it sets within 3 min. After 5 min. the former is removed, the jig is inverted and the refractory shape is pressed out. A small disc, which covers a hole in the jig used when casting the top half of the crucible, facilitates this operation. This procedure is repeated for the top half of the crucible, both halves being then dried for a few hours at 110 to 130 deg. C. to drive off all moisture. Next, the two halves are slowly fired over a period of 4 hrs. up to 1,000 deg. C. and then allowed to furnace cool to room temperature. Finally, they are fitted and located in position in the furnace carcase (Fig. 3), and a spinel mixture bonded with solution "C," which sets hard in a few minutes, is poured around the sections (Fig. 4). The furnace is dried out at 110 to 130 deg. C. for 6 to 12 hrs. before assembling the two halves together. Excellent results have been obtained with this method of furnace construction. When it is considered that the arc is operating within 3 in. of the refractory face, it will be realised that the conditions of service are both severe and searching.

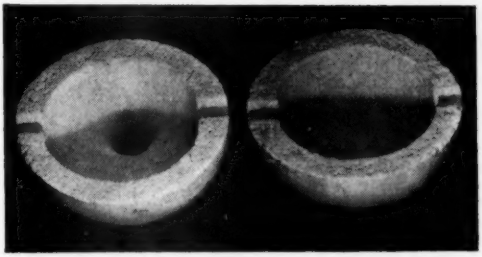


FIG. 1.—TWO HALVES OF THE CRUCIBLE FORMING THE INNER FURNACE LINING.

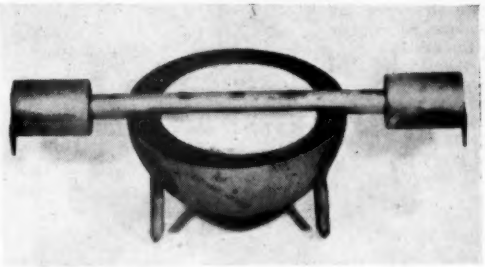


FIG. 2.—METHOD OF MOULDING THE FURNACE CRUCIBLES.

Ethyl Silicate in the Foundry

Another example of the use of refractories bonded with ethyl silicate is the lining of the gas and air tunnels on melting furnaces and high-temperature ovens. Here, a mixture of sillimanite and the spirit solution "B" is formed and rammed in position in the usual way as if lining normally with silicon carbide cement. After ramming in position and leaving for a few minutes, the wooden former can be withdrawn. The mixture is then left to air-dry slowly and thoroughly to harden before use. If desired, a torch may be applied to the mixture, when the excess alcohol will burn off and the mixture will harden rapidly.

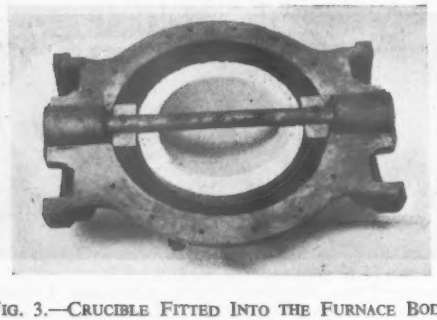


FIG. 3.—CRUCIBLE FITTED INTO THE FURNACE BODY.

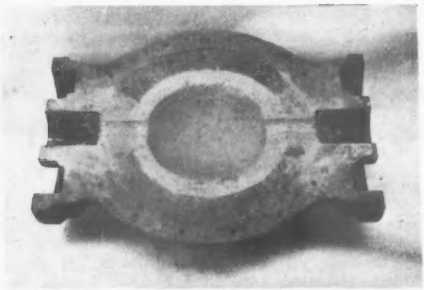


FIG. 4.—FINAL STAGE: SPINEL HAS BEEN INTRODUCED BETWEEN THE CRUCIBLE AND THE FURNACE BODY.

Special refractory bricks and shapes have also been made for both electric and crucible-type furnaces with satisfactory results. Another possibility is the prefabrication of specially-shaped runners which it is impossible to mould integrally with the remainder of the mould. These runners can be placed in position resting on the pattern, and formed *in situ* during the ramming of the sand into the moulding boxes.

PRODUCTION OF CORES

In the Report recently issued by H.M. Stationery Office, "Report of the Joint Advisory Committee on Conditions in Iron Foundries," commonly known as the Garrett Report, attention was drawn to the objectionable conditions created by the fumes liberated during the baking of cores. These fumes are emitted from the currently used bonding agents, *e.g.*, starch or sugar compounds, linseed oil, etc. Another point causing concern is the recent necessity for use of mineral oils in place of linseed oil, it being a retrograde step from the health point of view because of the postulated carcinogenic properties of some of them. Obviously, some new approach is required to the subject to try to find a material which does not evolve these objectionable gases.

The organic silicon compounds have been considered as possible core-bonding materials, and the following section outlines the procedure, and findings made. As is well known, the art of core-making is the production of cores which are an exact reproduction of the internal shape of a core box. The type of sand used to produce these cores is of prime importance, as it must possess certain main qualities:—(1) The "green" or undried state should be such that it enables the core to maintain its shape after it has been withdrawn from the core box; (2) the dry strength, *i.e.*, after the core has been thoroughly dried, must be such that it will resist the erosion of the metal as it flows into the mould, and maintain the shape long enough to allow the liquid metal to solidify; (3) the permeability must be such that any gases generated during casting, and any air in the core itself, can obtain quick exit to the atmosphere; (4) the ease of collapse after casting must be such that, as soon as the metal begins to solidify, then contraction can proceed with no undue strains or restrictions being placed upon the casting; (5) the core should be capable of being removed from the casting with the minimum of effort, and without damage to the casting.

Method of Core-making

Taking advantage of the fact that, upon hydrolysis, ethyl silicate deposits silicic acid in the form of a gel, it was decided to cast cores using the sand in the form of a slurry rather than to ram them by the conventional method, and with this in view, the following procedure was adopted:—(1) The surface of the core box was given a thin coating of Vaseline; (2) quantities of sand and solution were measured and mixed; (3) the mixture was poured into the core box and allowed to set (when sufficiently hard) —usually after a few minutes—the box was opened; (4) the core was carefully lifted out or extracted, the box being re-coated with Vaseline and closed ready for the next core.

Bonding Solution.—The bonding solution employed for the production of cores is the water solution "A" (see Appendix).

Refractory Mixture

Various refractory mixtures were tried using both Bedford sand and Molochite sand as a basis to which was added varying percentages of fines, usually one of

the aluminium silicates ground to a fine mesh. Table II gives the sieve analysis of the sands used.

TABLE II.—*Sieve Analysis of Sands Used for Cores.*

	Bedford sand.	Molochite sand (coarse grade).	Molochite sand (fine grade).
Retained on B.S. Sieve No. 16 ..	0.52	0.04	Nil
" " " " " 22 ..	2.3	0.05	0.05
" " " " " 36 ..	25.75	1.90	0.06
" " " " " 44 ..	27.15	10.10	0.07
" " " " " 60 ..	36.55	20.00	0.30
" " " " " 100 ..	7.9	20.00	0.37
" " " " " 150 ..	0.45	20.00	2.50
" " " " " 200 ..	0.05	13.75	59.15
" " " " " 300 ..	0.10	7.80	19.90
Passing through B.S. Sieve No. 300	0.10	6.36	17.60

The general mixtures investigated had the following ratios of coarse sand to fine sand:—90:10, 80:20, 70:30, and 60:40. It was soon found that the 90:10 mixture was much too weak in the dry state. The 70:30 and 60:40 mixtures were quite hard, but were not sufficiently permeable and gave castings which were badly blown. A compromise was thus made, concentrating on the 80:20 mixture. During these investigations it was soon realised that the time required for gellation of the silicate solution was materially affected by the quantity of magnesium oxide present, and the temperature and age of the bonding solution. Tests were conducted which are summarised in Fig. 5.

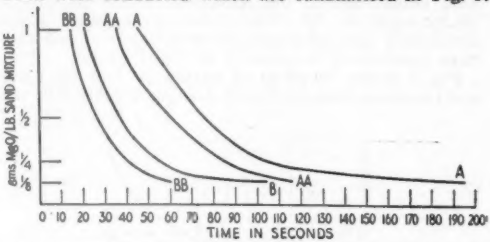


FIG. 5.—INFLUENCE OF MAGNESIUM OXIDE ON INVESTMENT SETTING TIME.

Sand Mixture: 80 per cent. Bedford + 20 per cent. Molochite No. 6, 1 lb. mixed with 160 cc. solution.
Curve A—New Solution at 17.5 deg. C.
Curve AA—New Solution at 26.5 deg. C.
Curve B—Aged Solution (6 days) at 17.5 deg. C.
Curve BB—Aged Solution (6 days) at 26.5 deg. C.

Mixtures have been tried for light-alloy core production replacing the 20 per cent. fine-grade material with 20 per cent. Plaster of Paris. This gives a core which is harder in the dry state than the 80:20 Bedford-Molochite mixture. It has been used successfully for casting both aluminium and magnesium. When casting magnesium, the surface of the core may be sprayed with a solution of ammonium bi-fluoride (20 gm. per 100 ml. of water) or 3 per cent. sulphur may be substituted for the same amount of the fine-grade molochite or plaster in the sand mixture. The 80:20 mixture has a low dry compression strength (50 lb. per sq. inch) and so it will collapse quite readily when metal is contracting round it, and is easily removed from the final casting.

Jointing of Cores

If two or more cores have to be assembled and joined together, this is best accomplished while the cores are still "green" or wet. The method employed is to fit the cores together and run a small quantity of the slurry into the joints by means of a spatula. This quickly sets and the excess can be cut easily and trimmed back to the correct smooth shape. The complete assembly is then dried.

Core-drying Procedure

When once the slurry is set it is best left to remain in the core box for a short time depending upon shape and section of the core in order that the silicic acid gel can harden sufficiently to allow the core to be handled easily and retain its shape. After air drying for an hour or two, the core is quite rigid and can be dried out in the core oven in the usual manner. Core-oven temperatures can be maintained between 100 and 300 deg. C., the time of drying being dependent upon the cross-sectional area of the core. The type of core oven best suited for drying the cores is one fitted with a forced-air circulating fan, although any standard type of core drying oven can be used.

Shrinkage

After the core has been cast and the silicic acid gel has hardened off, a certain amount of contraction takes place which allows the core to be removed easily from the core box. On subsequent drying further shrinkage takes place. This shrinkage amounts to as much as 0.020 in. per inch when using the mixtures 80 per cent. sand plus 20 per cent. fine grade Molochite. If the fine grade Molochite be replaced by 20 per cent. Plaster of Paris then this shrinkage is reduced to give an over-all shrinkage figure of 0.010 in. per inch. This contraction must be allowed for, together with the metal shrinkage, when the core box is being made. It was found during efforts to produce a core with greater dry strength, that fireclay had the opposite effect of Plaster of Paris and considerably increased the degree of shrinkage.

Venting

The venting of cores is an operation which requires the utmost consideration, for large volumes of air or gas have to be released very quickly. If there be no quick release then the gases or air are likely to try to obtain outlet through the metal, resulting in a blown casting. The methods employed in this cast-core process are (*a*) gallery vents and (*b*) hollow core vents. In the first method the vent wires are placed in the core box prior to the pouring operation and are withdrawn through the core box after the core has set, but before the stripping operation is carried out. In the second method, specially-shaped formers are placed inside the core box, leaving a space between the former and the walls of the core box of ¼ to 1 in. After the core has set, the former is withdrawn and the hollow core can then be removed from the box.

Ethyl Silicate in the Foundry

The core boxes, as well as accommodating vent wires and formers, should be made in such a manner as to facilitate the easy withdrawal of the cores. This may mean that the box is divided into a greater number of sections than would be normally considered necessary, but as no rapping is possible, then every other artifice must be used for extracting the core. One help is the inclusion of ejector pins in all boxes so as to ease the core out on to the carrier plate.

Advantages of the Process

(*a*) No objectionable fumes or gases are liberated on drying or casting.

(*b*) Little wear and tear on core boxes takes place, therefore fewer replacements are required.

(*c*) Greater accuracy and detail are possible.

(*d*) It is possible to re-use the core sand after re-milling and further addition of the accelerator.

Disadvantages of the Process

(1) The method is expensive.

(2) It is difficult to arrange vents in intricately-shaped cores.

(3) The inclusion of core wires is not satisfactory, as they restrict the shrinkage characteristics and cause the cores to rupture.

The production of cores by this process is more costly than those produced by normal methods using a standard core binder. The ratio of solution to refractory is approximately 250 ml. per lb. Thus. the cost to treat 28 lb. of sand with ethyl silicate solution is approximately 14s., whilst 3 per cent. dextrin-oil binder is approximately 7d. Although it is possible to make a substantial recovery of the core sand after use, this saving is small in relation to the over-all cost. Thus, on a cost basis, the evidence is overwhelmingly in favour of the more conventional type of binder, but there are certain technical advantages to be gained from using ethyl silicate which may warrant its use on specialised occasions.

Conclusions

In ethyl silicate, the foundryman has a material which lends itself to a number of applications. By carefully following a set procedure it is possible to make and use the solutions detailed in this Paper with little chemical skill. The only point which must be made is that ethyl silicate is expensive and its applications are therefore limited to specialised problems.

The Author is indebted to the Bristol Aeroplane Company for permission to publish this Paper.

(The Appendix to the Paper, in company with the discussion, will be published in our next issue.)

Core Sand Control

By Archibald Jamieson

In foundries employing oil-sand practice in their core shop, it is often found that a cheap local sand is used in the belief that this will help to keep down the otherwise high cost of the mixed sand. Such a practice was

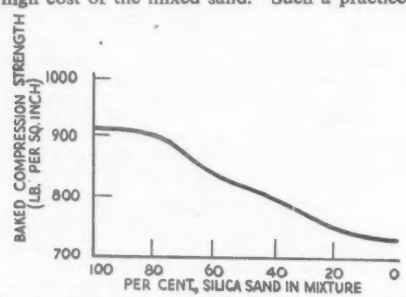


FIG. 1.—EFFECT OF MIXING SEA AND SILICA SAND.

employed in the foundry with which the writer is associated, where a local sea sand was used, and 3 per cent. (cereal oil) bond was required to give adequate strength to the cores. From time to time, however, trouble was encountered due to a small quantity of silt, or other harmful matter, being present in the sand, which resulted in low-strength cores and many core breakages.

A washed silica sand, with a similar grading to the sea sand, was examined, and it was found that the bond could be reduced to 2.4 per cent. without bringing the strength below that of a clean batch of sea sand with 3 per cent. bond. In spite of the higher initial cost of the washed sand, the final costs of the mixed sands were equal, due to the reduction in the quantity of binder required. The control tests have shown greater consistency since changing to this practice, and there have been fewer complaints of "bad" sand.

Fig. 1 shows the effect of mixing sea and silica sand and illustrates how the baked strength steadily falls with

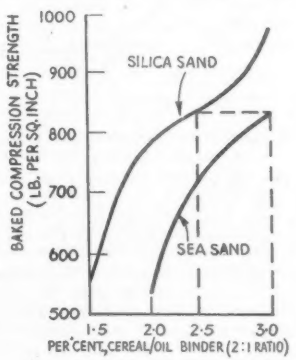


FIG. 2.—EFFECT OF VARYING BINDER IN EACH SAND.

increase in sea sand. Fig. 2 demonstrates the effect of varying the quantity of binder in each sand; it can be clearly seen that 2.4 per cent. bond in one sand gives the equivalent strength of 3 per cent. bond in the other. All natural sands do not vary as much as the sea sand in question, however, and some, of which Southport is an example, are almost as uniform as those washed.

Pig-iron and Steel Production in Great Britain

Summary of June Statistics

The following particulars of pig-iron and steel production in Great Britain have been extracted from the Statistical Bulletin for July, 1949, issued by the British Iron and Steel Federation. Table I gives the production of pig-iron and ferro-alloys in June, with the number of furnaces in blast; Table II, production of steel ingots and castings in June; and Table III, deliveries of finished steel. Table IV summarises steel industry activities during the six months ended June, 1949.

TABLE I.—*Weekly Average Production of Pig-iron and Ferro-alloys during May*, 1949. (*Thousands of Tons.*)

District.	Furnaces in blast, 2.7.49.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts, Northants, and Essex	26	0.1	13.6	25.8	1.5	—	41.0
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire / Yorkshire (incl. Sheffield, excl. N.E. Coast)	6	—	6.6	—	—	1.4	8.0
Lincolnshire	15	—	26.4	—	—	—	26.4
North-East Coast	23	8.2	36·1	0.4	—	1.4	46.1
Scotland	9	0.8	12.2	3.2	—	—	16.2
Staffs., Shrops., Worcs., and Warwick	9	—	9.0	1.5	—	—	10.5
S. Wales and Monmouthshire	8	4.0	18.5	—	—	—	22.5
North-West Coast	6	14.9	—	—	—	0.2	15.1
Total	102	28.0	122.4	30.9	1.5	3.0	185.8*
May, 1949	102	28.5	124.4	29.3	1.4	2.9	186.5
June, 1948*	101	26.4	123.8	26.1	1.9	2.9	181.1

TABLE III.—*Weekly Average Deliveries of Non-alloy and Alloy Finished Steel.* (*Thousands of Tons.*)

Product.	1947 (53 weeks).	1948.	1948. June*	1949. May.	1949. June.*
Non-alloy Steel:—					
Heavy rails and sleepers	7.6	8.9	10.3	9.5	10.1
Heavy and medium plates	31.6	36.2	38.3	42.3	41.7
Other heavy products	31.8	34.7	35.9	39.2	37.3
Light rolled products§	52.9	59.5	61.4	49.5	45.4
Hot-rolled strip				17.6	17.2
Cold-rolled strip	4.6	4.7	4.9	5.2	4.7
Bright steel bars	4.8	6.0	6.6	5.9	5.5
Sheets, coated and uncoated	24.3	26.3	27.2	28.1	26.9
Tin, terne and blackplate	12.1	13.5	14.7	14.7	12.9
Tubes, pipes and fittings	13.5	15.1	15.2	19.5	17.9
Wire	10.8	12.8	13.5	15.8	15.2
Tyres, wheels and axles	3.5	3.9	4.0	4.5	4.1
Forgings	5.0	6.0	6.9	6.6	6.4
Castings	3.0	3.5	3.8	3.5	3.4
Total	205.5	231.1	242.7	261.9	248.7
Alloy Steel†:—					
Tubes and pipes	0.3	0.4	0.3	0.4	0.5
Bars, sheets, strip and wire	3.7	4.7	5.1	5.2	4.4
Forgings	1.8	2.5	2.9	2.9	2.6
Castings	0.6	0.7	0.7	0.6	0.6
Total	6.4	8.3	9.0	9.1	8.1
Total U.K. production‡	211.9	239.4	251.7	271.0	256.8
Less intra-industry conversion	19.2	29.0	32.1	37.9	35.0
Net U.K. deliveries	192.7	210.4	219.6	233.1	221.8
Add imported finished steel	2.2	3.4	3.6	12.3	13.7
Total deliveries of finished steel	194.9	213.8	223.2	245.4	235.5

† Excludes high-speed steel. ‡ Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
§ Excl. wire rods and alloy steel bars, but incl. ferro-concrete bars

TABLE II.—*Weekly Average Production of Steel Ingots and Castings, June*, 1949. (*Thousands of Tons.*)

District.	Open hearth. Acid.	Open hearth. Basic.	Bessemer.	Electric.	All other.	Total. Ingots.	Total. Castings.	Total ingots and castings.
Derby, Leics., Notts., Northants and Essex	—	—	10.7(Basic)	1.5	0.2	11.8	0.6	12.4
Lancs. (excl. N.W. Coast), Denbigh, Flints., and Cheshire / Yorkshire (excl. N.E. Coast and Sheffield)	1.4	20.3	—	1.2	0.4	22.4	0.9	23.3
Lincolnshire	—	30.1	—	—	0.1	30.1	0.1	30.2
North-East Coast	1.8	58.9	—	0.7	0.5	60.4	1.5	61.9
Scotland	4.8	41.5	—	2.0	0.7	47.2	1.8	49.0
Staffs., Shrops., Worcs. and Warwick	—	14.8	—	0.6	0.4	14.9	0.9	15.8
S. Wales and Monmouthshire	9.3	46.4	5.5(Basic)	0.9	0.1	61.9	0.3	62.2
Sheffield (incl. small quantity in Manchester)	7.8	22.8	—	7.1	0.6	36.6	1.7	38.3
North-West Coast	0.4	2.2	4.8 (Acid)	0.3	0.1	7.7	0.1	7.8
Total	25.5	237.0	21.0	14.3	3.1	293.0	7.9	300.9*
May, 1949	28.7	245.5	22.1	15.8	3.5	306.8	8.8	315.6
June, 1948*	27.2	230.1	20.8	15.2	3.7	288.4	8.6	297.0

* Five weeks.

(*Continued at foot of following page.*)

Company Results

(Figures for previous year in brackets.)

FODENS—Dividend of 10% (same).

RANGE BOILERS—Interim dividend of 5% (same).

BRIGHTSIDE FOUNDRY & ENGINEERING COMPANY—Dividend of 50% (35% and bonus of 15%).

UNITED GAS INDUSTRIES—Final ordinary dividend of 12%, making 17% (same). Dividend of 1s. 9d. per share on the deferred shares (same).

LARMUTH & BULMER—Net profit for the year ended March 31, £13,181 (£6,327); final dividend of 10%, making 15% (same); forward, £21,862 (£14,878).

ASSOCIATED LEAD MANUFACTURERS—Trading profit for 1948, £485,914, plus exceptional profit of £2,188; interim dividend, £169,279, tax free; forward, £79,740.

MUREX—Total consolidated income for the year ended April 30, £874,268 (£696,713 in the previous 10 months); tax, £376,433 (£299,748); pension fund, £19,500 (nil); consolidated net profit, £311,550 (£250,509); surplus on sale of shares in an associated company, £41,425 (£32,499); to general reserve, £230,000 (£183,000); final dividend of 12½%, making 20% (16⅔%); forward, £127,645 (£125,395).

WILLIAM JACKS & COMPANY—Consolidated net profit for 1948, after writing off expenses of conversion to a public company, £250,792 (£189,115); taxation, £150,000 (£114,372); available, £116,308 (£102,287); stock reserve, £15,700 (£11,205); taxation contingencies reserve, £24,000 (nil); general reserve, £20,000 (£45,000); preference dividend, £1,169 (same); ordinary dividend of 25% (22½%), on increased capital, £25,052 (£16,397); forward, £30,387 (£28,516).

WARNER & COMPANY—Trading profit for the year to June 30, after charging £2,094 special expenditure on plant, £22,694 (£15,279); other income, £981 (£1,129); to taxation, £12,000 (£8,000); depreciation, £1,500 (same); directors' fees, £650 (same); (other emoluments, £2,533, previous year, £2,000); audit, £109 (£89); net profit, £9,416 (£6,169); final dividend of 7½% and bonus of 5%, making 15% (12½%); reserve plant replacement, £3,000 (nil); forward, £8,239 (£6,608).

BELLISS & MORCOM—Consolidated trading profit for the year ended March 31, £71,075 (£38,050); investments income, £23,090 (£24,146); depreciation, £27,597 (nil); reserve for replacement of fixed assets, nil (£15,000); profits tax, £12,400; income tax, £27,528 (taxation, £18,479); written off patents, nil (£6,308); from general reserve, £28,276 (nil); available, £60,863 (£63,038); preference dividend, £3,526 (same); ordinary dividend of 4%, £13,074 (same), and final dividend of 8½% (10%), £27,783 (£32,685); forward, £16,480 (£13,753).

House Organs

Albion Works Bulletin, Vol. 3, No. 7. Published by John Harper & Company, Limited, and John Harper (Meehanite), Limited, Willenhall. A warning is given by the Joint Production Committee following an announcement that absenteeism had increased that "employees who are losing unnecessary time should realise that this may affect the security of their employment, particularly when the labour supply position is easing." Other warnings are given as to the danger of cycling in the works and the omission to wear safety boots and spats. These are essential, because the results of slackness are in every case the same—a reduction in the strength of the working force either through dislocation or by sending up costs. The latter would have the effect of jeopardising the obtaining of orders, which, in the long run, would be bound to affect general employment. Thus, as usual, the Albion Bulletin contains a lesson of the widest application.

Joint Consultation Issue of Ingot, the house organ of Richard Thomas & Baldwins, Limited. Price 3d. This issue is a very fine testimonial of the mutual advantages to be derived from joint consultation. Being a very large concern a survey has been made of the operation of many committees. In a sort of postscript, Mr. E. H. Lever deplores the gaps which still exist within the organisation. We wonder if they represent *locales* where joint consultation is unnecessary, for many people believe they exist. The colour printing and the general presentation is of the highest standard, and it will, no doubt, create greater interest in the work of joint consultation than hitherto.

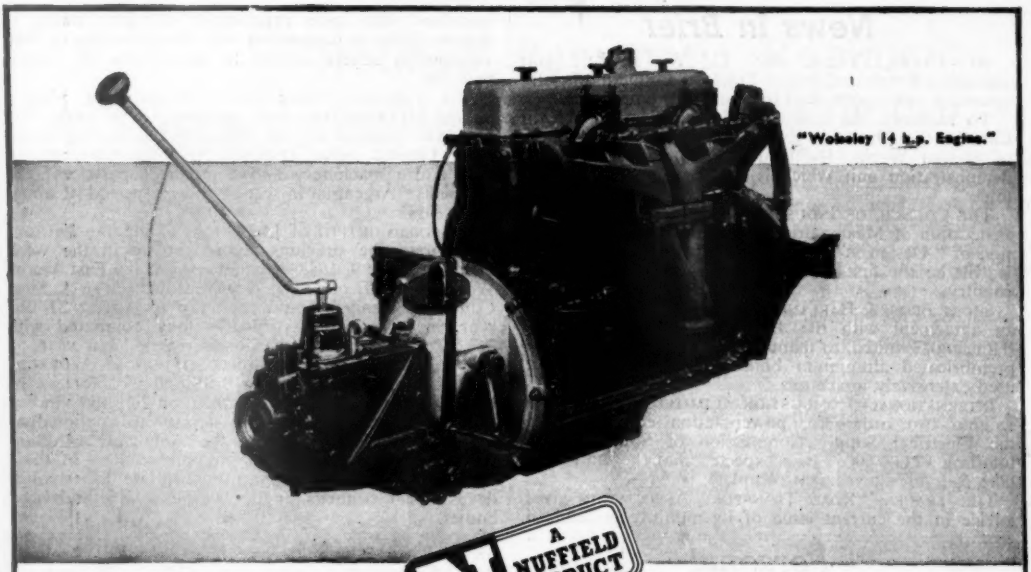
Foseco Foundry Practice, No. 96. Published by Foundry Services, Limited, Long Acre, Nechells, Birmingham. This issue contains some useful notes on reclamation of discarded crucibles, such as, for instance, the making of stirrers, by pasting on to the ragged end of a steel bar ground-up crucible material bonded with core gum. The usual features—" Definitions " and " Ironfounding "—are also included.

PIG-IRON AND STEEL PRODUCTION IN GREAT BRITAIN (*Continued from previous page*).

TABLE IV.—*General Summary of Pig-iron and Steel Production.* (*Weekly Average in Thousands of Tons.*)

Period.	Iron-ore output.	Imported ore consumed.	Coke receipts by blast-furnace owners.	Output of pig-iron and ferro-alloys.	Scrap used in steel-making.	Steel (incl. Alloy).			
						Imports.‡	Output of ingots and castings.	Deliveries of finished steel.	Stocks.†
1938	228	89	—	130	118	16	200	—	—
1947 (53 weeks)	209	136	165	147	145	8	240	195	797
1948	252	172	200	178	174	8	286	214	1,028
1949—January	269	163	202	178	178	8	289	224	1,019
February	267	160	201	181	198	13	311	236	1,000
March*	263	158	198	179	199	20	313	242	1,031
April	255	163	198	179	192	20	305	226	1,097
May	263	171	201	187	199	22	316	245	1,121
June*	268	168	202	186	188	28	301	236	1,178

* Five weeks. † Stocks at the end of the years and months shown. ‡ Weekly average of calendar month.



A NUFFIELD PRODUCT

Using

STANTON-DALE

REFINED PIG IRON

USED AND RECOMMENDED
FOR ALL HIGH-DUTY
ENGINEERING CASTINGS

THE STANTON IRONWORKS COMPANY LIMITED, Nr. NOTTINGHAM

News in Brief

AT EARBY, Yorks, Mr. C. W. Jowitt, joint managing director of Bristol Tractors, Limited, officially opened a new sports field for the firm's employees.

TO PROMOTE the sale of its mechanical shovels in Canada, the Chaseside Engineering Company, Limited, of Station Works, Hertford, has organised a mobile demonstration unit which is making a trans-continent tour.

THE COUNCIL OF INDUSTRIAL DESIGN and the British Federation of Master Printers are presenting an exhibition of "Design in Business Printing" in March, 1950. It will be the first of its kind ever to be held in this country.

SHORT BROS. & HARLAND, LIMITED, Belfast, has made an agreement with the Bristol Aeroplane Company (Housing), Limited, to manufacture in Northern Ireland prefabricated aluminium buildings of the type being used extensively in schools.

INTERNATIONAL COMBUSTION, LIMITED, Derby, has secured two orders for power-station equipment for the Electrical Supply Commission of South Africa, totalling £2,000,000. It is expected that the work will take four to six years to complete.

THE TRADERS' ROAD TRANSPORT ASSOCIATION gives advice in the current issue of its monthly bulletin to members who have experienced difficulty owing to delays arising in connection with the unloading of their vehicles in streets subject to restrictions on waiting vehicles.

THE LARGEST ORDER for water-pumping plant—valued at £1,000,000—ever received by a single firm has been secured by the Harland Engineering Company, Limited, Alloa, from the Argentine Government. The entire machinery and component parts will be shipped to Argentina in sections over a period of about five years.

A RECORD OUTPUT of 14,399 tons of ingots—290 tons more than the previous record set up in the week ended October 9, 1948—was attained at the East Moors Works, Cardiff, of Guest Keen Baldwins Iron & Steel Company, Limited, last week. Up to August 21 this year, ingot output was 374,039 tons, compared with 363,560 tons for the corresponding period last year.

THE AMALGAMATED UNION OF FOUNDRY WORKERS has tabled a motion for the Bridlington conference of the T.U.C. calling for an examination of the founding and engineering industries as a step towards nationalisation. An amendment from the Amalgamated Engineering Union suggests that in some sections of these industries it might be more appropriate to establish development councils or non-statutory joint advisory bodies.

Personal

MR. NORMAN F. H. RAILING has been appointed to the board of Metal Traders, Limited.

MR. DANIEL MACEWEN LAWSON, secretary of Herbert Morris, Limited, engineers, of Loughborough, and MR. FRANK SOMNER MARSHALL, general works manager, have been appointed directors of the company.

MR. CECIL BENTHAM has now retired from the board of Henry Simon (Holdings), Limited, but is continuing active engineering and industrial work on his own account, trading as Cecil Bentham, Limited, 334, Wellington Road North, Stockport.

MR. A. A. POLLOCK, a director and chief mechanical engineer of the British Thomson-Houston Company, Limited, Rugby, has retired, but will remain available in a consultative capacity. MR. K. R. HOPKIRK will succeed him as chief mechanical engineer.

MR. TOM BROWN has been appointed to the board of Sheepbridge Engineering, Limited. Formerly chief engineer of the engines branch of Morris Motors, Limited, he left the Nuffield organisation 14 months ago to become managing director of Sheepbridge Stokes Centrifugal Castings Company, Limited.

MR. ALFRED EDWARDS, Independent M.P. for Middlesbrough East, has joined the Middlesbrough Conservative Association and applied for the Conservative Whip. Mr. Edwards was expelled from the Labour Party in May last year because of his political activity and conduct in opposing the Government's intention to nationalise the iron and steel industry.

MR. DAVID G. BROWN, managing director of the Redheugh Iron & Steel Company (1936), Limited, Gateshead, has been elected chairman of the Tyneside District Advisory Committee of the Northern Regional Board for Industry in succession to MR. G. M. SMIBERT, formerly of Richardsons, Westgarth & Company, Limited, marine engineers, of Hartlepool, who has taken up a post in Scotland.

MR. PERCY JACKSON, who has been appointed chairman of the research department of the British Internal Combustion Engine Manufacturers' Association, is in charge of the development and research department of William Doxford & Sons, Limited, shipbuilders, of Sunderland. He was formerly chief engineer of Mirrlees, Bickerton & Day, Limited, oil-engine manufacturers, of Stockport, and has also been technical director of Associated British Oil Engines, Limited.

Wills

LUX, ERICH, managing director of Metal Alloys (South Wales), Limited, Pontypridd £10,245

BAKER, H. G., a former director of John Baker & Sons, Limited, steel manufacturers, of Sheffield ... £33,914

HAYHOE, E. W., secretary of H. Brahams & Company, Limited, scrap-metal merchants, of Bury St. Edmunds £10,638

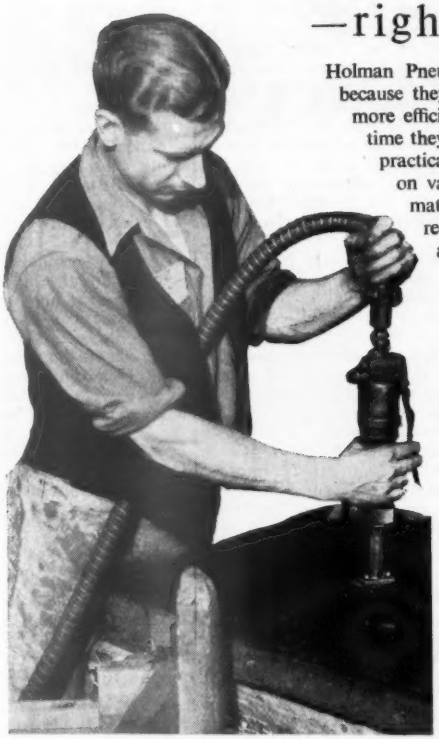
CHARNOCK, MILFORD, formerly principal of Milford Charnock & Sons, iron and steel merchants, etc., of Halifax £6,487

HORTON, E. G., late of George Mann & Company (Iron & Steel), Limited, Fenchurch Street, London, E.C.3, and a member of the Baltic Exchange ... £26,708

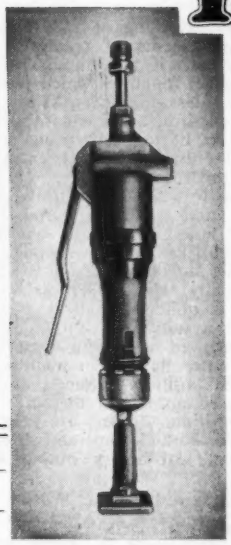
HATTERSLEY, R. E., chairman and managing director of Hattersley (Ormskirk), Limited, brassfounders, and Erskine, Heap & Company, Limited, electrical switchgear manufacturers, of Salford £981,685

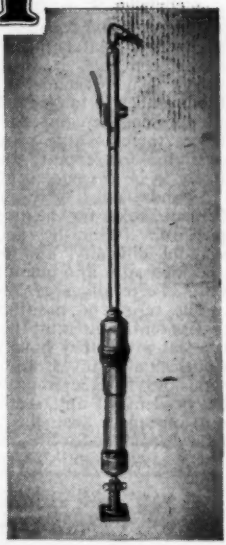
HORN, BERTRAM, for many years representative of Mirrlees, Bickerton & Day, Limited, Diesel-engine manufacturers, of Stockport, and the Mirrlees Watson Company, Limited, engineers, founders, etc., of Glasgow £4,329

Holman Pneumatic Rammers —right on top of the job



Holman Pneumatic Rammers are welcomed by workers in many industries because they cut out the toil of packing loose materials, doing the job far more efficiently and quickly than it can be done by hand. At the same time they please managements because they save time and labour and are practically foolproof. Their special feature is their effectiveness even on varying levels of material, the piston stroke adjusting itself automatically. The range covers almost all "bench" and "floor" requirements, and various sizes and shapes of butts and peins are available. Full details and recommendations supplied on request.





Bench Type : Sizes 0 and 10

Floor Type : Sizes 20 and 30

Type	Size	Length ins.	Weight lbs.
Bench ...	0	17	9
Bench ...	10	23	18
Floor ...	20	48	22
Floor ...	30	47	27

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H.13

Raw Material Markets

Iron and Steel

It is hoped that this month will witness increased activity in the foundry trade, as although many works are engaged to the extent of their production, a number of them would welcome larger order-books, particularly for forward commitment. The demand for pig-iron from all users is still substantial and present commitments absorb all grades of foundry iron and hematite. The production of high-phosphorus iron is maintained at a steady level and the light foundries, generally, take up all available tonnages. An increase in output of this grade is expected shortly, but supplies will still not be in excess of requirements. Many of these foundries have not been able to obtain all the iron they need for some time, and licensed tonnages are very often not completed.

There is also a persistent demand for low- and medium-phosphorus pig-iron and hematite for the engineering, speciality and jobbing foundries, and no difficulty is experienced in disposing of all tonnages that arise. After the requirements of regular users have been met, it is difficult, if not impossible, to satisfy demands made by other foundries which require these grades to implement orders on hand. As long as the present demand for pig-iron and hematite continues there is little prospect of tonnages being made available for export, and only the refined grade is likely to be considered in this respect.

Foundry coke is coming forward satisfactorily, and furnace coke for heating and core-oven purposes is plentiful. Ganister and limestone can be obtained without difficulty, and firebricks can be supplied to specified sizes and quantities for delivery from production. Ferro-alloys can usually be secured promptly.

The re-rollers' position is quite satisfactory, as the orders on hand permit them to utilise the better supplies of steel which they have received from both home and Continental sources; the latter have been mainly responsible for the improved position. Sheets are in heavy demand and increased outputs at the mills do not appear to ease the position. Users are making heavy demands for all grades both at home and abroad. The heavy re-rollers report satisfactory outputs.

Non-ferrous Metals

Stocks of refined copper held by producers at the end of July, according to the American Copper Institute, were 212,817 short tons, a gain of about 46,000 tons on the previous month. In addition, of course, there is an unknown quantity held in the stockpile by the Government. Nevertheless, the copper market in New York is firm and there was a rise of ¼ cent in the price of copper scrap last week. This may have been on account of the better deliveries to domestic consumers in August, which will, it is believed, amount to about 70,000 short tons; in July the corresponding figure was 45,316 tons.

There was an interesting development in tin last week in America, for on Saturday it was reported that the Commerce Department in Washington had announced the lifting of the wartime ban on importation of the metal by private interests. Moreover, controls on the use of tin were lifted. Temporarily there are some exceptions to the new decree, but within three months these, too, will have been removed. It will be necessary for intending importers to obtain licences before they purchase foreign tin, but there is not much hardship in that. This development has been expected for some time, but it is none the less interesting, and may have far-reaching effects on the situation in Britain. It is too early yet to see what changes will occur in the U.S. price for tin, but most traders expect a drop in values.

Non-ferrous metal business in Britain is reasonably good, and may develop still further now that the holiday season is over. Prices of scrap have firmed up, for not only is there more confidence in the American price structure, but the possibility of devaluation encourages the belief that sterling values may rise later in the year. There is, of course, still a considerable gap between old and new metal values, and this gives every encouragement to the consumers to take maximum quantities of secondary metal. Brass swarf is dearer in face of a better demand, and brassfoundries are reported to be encountering more inquiry for their products. Government sales of brass continue, regular offers by tender being made of 70/30 shell cases, etc.

Foundry Courses in London

Technical schools will re-open this month and daytime and evening instruction in the theory and practice of foundrywork will be resumed in many centres. Details of the training in foundrywork provided at three of the technical colleges in London for the 1949-50 session, are as follow:—

Borough Polytechnic, Borough Road, S.E.1. Enrolment September 19-21 (5.30 to 8 p.m.). Classes begin September 26. A full-time instructor has been engaged. The part-time day classes are held on Tuesdays, Thursdays and Fridays, from 9.0 a.m. to 4.30 p.m. The evening classes are held Mondays to Fridays, from 6.30 to 9.0 p.m.

South-East London Technical College, Lewisham Way, S.E.4. Part-time day courses on Fridays, 9.0 a.m. to 5.15 p.m., with practical work at J. Stone & Company, Limited, Charlton, on Mondays, 6.45 to 9.15 p.m. Evening classes (if sufficient numbers enrol) on Mondays, Tuesdays and Fridays, 6.45 to 9.15 p.m.

Poplar Technical College, Poplar High Street, E.14. Part-time day release classes begin September 5. Tuesdays, Wednesdays, Thursdays and Fridays, 9 a.m. to 5 p.m.; practical, Mondays and Tuesdays, 6.45 to 9.15 p.m. Evening classes begin September 26. Mondays, Tuesdays, Thursdays, and Fridays.

A complete syllabus can be obtained on application to the principals of the respective colleges.

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Imports and Exports of Iron and Steel

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in July. Figures for the same month in 1947 and 1948 are given for purposes of comparison.

Total Exports of Iron and Steel.

Destination.	Month ended July 31.		
	1947.	1948.	1949.
	Tons.	Tons.	Tons.
Channel Islands	814	817	947
Gibraltar	228	419	134
Malta and Gozo	184	699	429
Cyprus	234	388	559
British West Africa	5,739	3,544	7,628
Union of South Africa	14,753	16,565	16,020
Northern Rhodesia	922	1,997	2,826
Southern Rhodesia	1,200	4,923	8,210
British East Africa	4,020	6,851	9,142
Mauritius	195	800	485
Bahrein, Koweit, Qatar and Trucial Oman	3,411	2,616	1,493
India	7,859*	5,841	10,511
Pakistan		1,546	5,782
Malaya	3,452	3,801	4,281
Ceylon	1,421	1,757	3,441
North Borneo	972	1,698	436
Hong Kong	2,241	4,658	1,647
Australia	2,712	5,925	17,264
New Zealand	3,982	4,610	9,355
Canada	2,109	4,062	7,700
Bermuda	42	87	61
British West Indies	4,320	6,462	3,670
British Guiana	184	441	420
Anglo-Egyptian Sudan	1,231	755	1,382
Other British countries	399	1,080	520
Irish Republic	7,481	6,937	4,898
Russia	14	—	41
Finland	4,495	7,271	7,689
Sweden	12,267	8,490	6,148
Norway	5,601	6,179	5,025
Iceland	433	341	865
Denmark	11,149	9,369	8,004
Poland	106	481	182
Germany	5	55	11
Netherlands	9,070	7,277	10,167
Belgium	1,253	829	921
France	2,946	2,764	2,263
Switzerland	1,676	1,865	699
Portugal	1,514	1,498	1,552
Spain	516	912	480
Italy	524	102	298
Hungary	102	304	254
Czechoslovakia	95	30	1
Greece	2,445	337	416
Turkey	937	2,102	3,763
Dutch East Indies	2,962	2,132	2,407
Dutch West India Islands	1,525	410	744
Belgian Congo	242	13	258
French W. and Eq. Africa	75	27	44
Portuguese East Africa	156	381	326
Canary Islands	134	409	145
Syria	329	722	78
Lebanon	738	2,998	1,637
Palestine (Israel)	5,251	769	1,718
Egypt	4,643	3,705	7,289
Morocco	102	126	9
Iraq	8,821	3,732	5,099
Iran	8,416	6,744	14,499
Burma	2,240	3,113	706
Siam (Thailand)	781	369	430
China	10,080	1,235	120
U.S.A.	1,626	199	174
Cuba	560	48	85
Colombia	629	404	572
Venezuela	3,863	5,108	3,209
Ecuador	630	183	220
Peru	379	92	645
Chile	1,487	1,860	513
Brazil	1,834	1,940	1,477
Uruguay	1,674	629	625
Argentine	10,143	16,539	4,511
Other foreign countries	1,329	1,033	3,713
Total	195,902	194,405	219,273

* Figures for 1947 relate to British India.

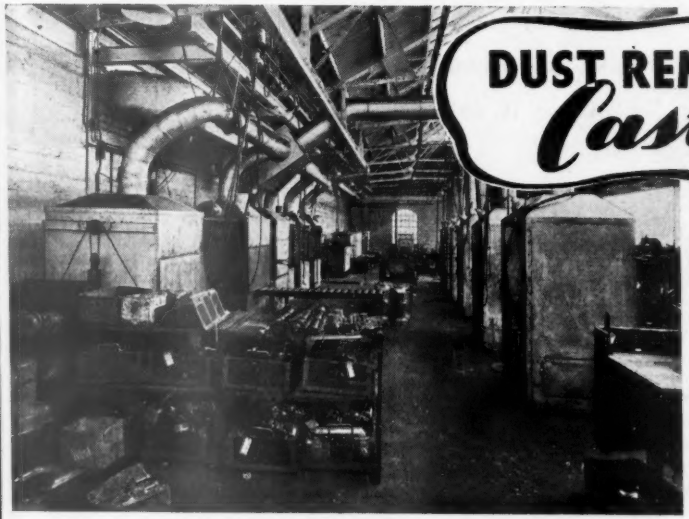
Total Imports of Iron and Steel.

From	Month ended July 31.		
	1947.	1948.	1949.
	Tons.	Tons.	Tons.
Australia	3,820	1,637	63
Canada	8,905	6,535	4,957
Other British countries and Irish Republic	55	361	3,788
Sweden	1,204	1,477	973
Norway	2,522	3,153	2,070
Germany	7	300	3,949
Netherlands	41	4,533	8,113
Belgium	5,558	12,980	31,967
Luxemburg	1,529	2,562	18,464
France	85	4,267	20,729
U.S.A.	18,596	8,535	42,578
Other foreign countries	51	259	4,730
Total	42,373	46,599	142,381
Iron ore and concentrates—			
Manganiferous	640	9,353	—
Other sorts	745,581	927,143	861,793
Iron and steel scrap and waste, fit only for the recovery of metal	78,567	95,329	428,167

Exports of Iron and Steel by Products.

Product.	Month ended July 31.		
	1947.	1948.	1949.
	Tons.	Tons.	Tons.
Pig-iron	6,974	153	842
Ferro-alloys, etc.—			
Ferro-tungsten	74	114	44
Spiegeleisen, ferro-manganese	341	56	938
All other descriptions	76	44	176
Ingots, blooms, billets and slabs	469	168	132
Iron bars and rods	1,205	736	459
Sheet and tinplate bars, wire rods	558	214	203
Bright steel bars	2,554	2,026	1,103
Other steel bars and rods	14,261	10,869	17,240
Special steel	1,459	1,481	1,270
Angles, shapes and sections	9,016	9,331	11,217
Castings and forgings	569	569	910
Girders, beams, joists and pillars	2,196	2,214	2,305
Hoop and strip	4,740	3,527	4,858
Iron plate	158	273	412
Steel plate, ¼ in. thick and over	14,504	11,254	21,511
Do., under ¼ in. thick	11,907	9,581	12,766
Galvanised sheets	6,926	9,140	8,009
Tinplates	12,049	14,895	19,934
Tinned sheets	780	472	233
Terneplates	126	—	6
Decorated tinplates	196	257	—
Other coated plates	301	331	846
Cast-iron pipes, up to 6-in. dia.	5,735	7,098	5,913
Do., over 6-in. dia.	4,515	6,954	6,926
Wrought-iron tubes	25,390	28,206	27,412
Radiators, central-heat boilers§	567	308	297
Railway material	9,804	23,636	23,658
Wire	3,865	3,788	5,375
Cable and rope	2,559	3,151	2,936
Netting, fencing and mesh	1,567	1,504	1,779
Other wire manufactures	569	818	1,084
Nails, tacks, studs, etc.	901	1,251	811
Rivets and washers	781	855	752
Wood screws	374	263	313
Bolts, nuts and metal screws	2,070	2,486	2,338
Stoves, grates, etc. (excl. gas)	554	1,293	822
Do., gas	271	323	259
Sanitary cisterns	94	166	213
Baths, sinks, etc.	237	934	835
Fencing material	786	489	665
Anchors, etc.	961	967	814
Chains, etc.	935	823	826
Springs	404	455	906
Hollow-ware	7,843	6,655	6,517
All other manufactures*	33,681	24,297	22,408
Total	195,902	194,405	219,273

* Figures for 1949 are not completely comparable with those for previous years.



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Current Prices of Iron, Steel and Non-ferrous Metals

(Delivered, unless otherwise stated)

August 31, 1949

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £10 4s.; Birmingham, £10 0s. 6d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £11 15s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si)—North Zone, £12 2s. 6d.; South Zone, £12 5s.

Scotch Iron.—No. 3 foundry, £11 18s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £12 14s. 6d.; South Zone, £12 17s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £13 4s. 6d.; South Zone, £13 7s.

Cold Blast.—South Staffs, £15 16s. 6d.

Hematite.—Si up to 2½ per cent., S & P over 0.03 to 0.05 per cent.; N.-E. Coast and N.-W. Coast of England, £11 16s. 6d.; Scotland, £12 3s.; Sheffield, £12 9s.; Birmingham, £12 15s.; Wales (Welsh iron), £11 16s. 6d.

Spiegeleisen.—20 per cent. Mn, £17 8s.

Basic Pig-iron.—£9 17s. 6d., all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.)

Ferro-silicon (6-ton lots).—20/30 per cent., £25 15s.; 40/55 per cent., £32 10s.; 70/85 per cent., £49.

Ferro-vanadium.—35/50 per cent., 15s. per lb. of V.

Ferro-molybdenum.—70/75 per cent., carbon-free, 6s. 5d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, 1s. 3½d. lb.

Ferro-tungsten.—80/85 per cent., 7s. lb.

Tungsten Metal Powder.—98/99 per cent., 8s. lb.

Ferro-chrome.—4/8 per cent. C, £60; max. 2 per cent. C, 1s. 5d. lb.; max. 1 per cent. C, 1s. 5½d. lb.; max. 0.15 per cent. C, 1s. 6½d. lb.

Cobalt.—98/99 per cent., 12s. lb.

Metallic Chromium.—96/98 per cent., 5s. 1d. lb.

Ferro-manganese (blast-furnace).—78 per cent., £25 3s.

Metallic Manganese.—94/96 per cent., carbon-free, 1s. 9d. lb

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.—BASIC: Soft, u.t., £16 16s. 6d.; tested, up to 0.25 per cent. C (100-ton lots), £17 1s. 6d.; hard (0.42 to 0.60 per cent. C), £18 16s. 6d.; silico-manganese, £23 19s.; free-cutting, £20 1s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £22 4s.; case-hardening, £23 1s. 6d.; silico-manganese, £26 6s. 6d.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £19 16s. 6d.; basic, hard, over 0.41 up to 0.60 per cent. C, £21 1s. 6d.; acid up to 0.25 per cent. C, £23 1s. 6d.

Sheet and Tinplate Bars.—£16 16s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Plates, ship (N.-E. Coast), £20 14s. 6d.; boiler plates (N.-E. Coast), £22 2s.; chequer plates (N.-E. Coast), £22 19s. 6d.; heavy joists, sections and bars (angle basis), N.-E. Coast, £19 13s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £22 6s.; flats, 5 in. wide and under, £22 6s.; rails, heavy, f.o.t., £19 2s. 6d.; hoop and strip, £23 1s.; black sheets, 17/20 g., £28 16s.

Alloy Steel Bars.—1-in. dia. and up: Nickel, £35 6s. 6d. nickel-chrome, £49 18s. 6d.: nickel-chrome-molybdenum £55 0s. 9d.

Tinplates.—I.C. cokes, 20 × 14, per box, 41s. 6d., f.o.t. makers' works.

NON-FERROUS METALS

Copper.—Electrolytic, £107 10s.; high-grade fire-refined, £107; fire-refined of not less than 99.7 per cent., £106 10s.; ditto, 99.2 per cent., £106; black hot-rolled wire rods, £116.

Tin.—99 to under 99.75 per cent., £569; 99.75 to under 99.9 per cent., £572 10s.; min. 99.9 per cent., £577.

Zinc.—G.O.B. (foreign) (duty paid), £63 10s.; ditto (domestic), £63 10s.; "Prime Western," £63 10s.; electrolytic, £64 5s.; not less than 99.99 per cent., £65 15s.

Lead.—Good soft pig-lead (foreign) (duty paid), £87 5s.; ditto (Empire and domestic), £87 5s.; "English," £88 15s.

Zinc Sheets, etc.—Sheets, 10g. and thicker, ex works, £77 10s.; rolled zinc (boiler plates), ex works, £75 10s.; zinc oxide (Red Seal), d/d buyers' premises, £63 10s.

Other Metals.—Aluminium, ingots, £93; antimony, English, 99 per cent., £160; quicksilver, ex warehouse, £18 10s.; nickel, £224.

Brass.—Solid-drawn tubes, 19½d. per lb.; rods, drawn, 10½d.; sheets to 10 w.g., 16d.; wire, 16½d.; rolled metal, 14½d.

Copper Tubes, etc.—Solid-drawn tubes, 19½d. per lb.; wire, 144s. 9d. per cwt. basis; 20 s.w.g., — per cwt.

Gunmetal.—Ingots to L.G.2 (85/5/5/5), £77 to £90; L.G.3 (86/7/5/2), £80 to £118; Gl (88/10/2), £126 to £156 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £126 to £170; L.P.Bl, £88 to £118 per ton.

Phosphor Bronze.—Strip, 22½d. per lb.; sheets to 10 w.g., 24½d.; wire, 24½d.; rods, 23d.; tubes, 27½d.; chill cast bars: solids, 23d., cored, 24d.; 10 per cent. phos. cop., — ; 15 per cent. phos. cop., — ; phosphor tin (5 per cent.), — . (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 1s. 4½d. per lb. (7%) to 2s. 1d. (30%); rolled metal, 3 in. to 9 in. wide, × .056, 1s. 10½d. (7%) to 2s. 7d. (30%); to 12 in. wide, × .056, 1s. 11d. to 2s. 7½d.; to 25 in. wide, × .056, 2s. 1d. to 2s. 9½d. Spoon and fork metal, unsheared, 1s. 9½d. to 2s. 5½d. Wire, 10g., in coil, 2s. 3½d. (10%) to 3s. 0½d. (30%). Special quality turning rod, 10%, 2s. 2½d.; 15%, 2s. 7d.; 18%, 2s. 11d.

New Catalogues

Core Blowers.—The foundry industry will welcome the issue of this four-page leaflet by British Ronceray, Limited, of Hatton House, The Square, Dunstable, Beds, as it deals with the Bedford core blower—a relatively new machine which incorporates a novel principle in core-making. The pamphlet is nicely laid out and good use has been made of colour printing. It is available to our readers on application to Dunstable.

Fans and Structural Engineering. Musgrave & Company, Limited, of St. Ann's Works, Belfast, has just issued a neatly-produced brochure, which in its 36 pages illustrates typical examples of the firm's products. These have been well selected and well set out. This was essential as only a minimum of letterpress is incorporated.

Malleable Castings. Using the title "Shock Proof," the Lake City Malleable Company, 5000, Lakeside Avenue, Cleveland, 14, Ohio, U.S.A., has issued a well-illustrated 92-page book which is the finest effort to sell castings that the reviewer has so far encountered. It is decorated throughout by humorous pictures, which obviously will make a greater appeal to domestic rather than overseas readers. It is divided into 11 sections and an excellent psychological touch is to be observed in some. For instance, "Conditions of Sale" becomes "Relationship of Users," or again, the selling points are put forward as "questions and answers." The reviewer accords full marks to those responsible for the production of such a likeable "sales talk."

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference E.P.D. or C.R.E. can be obtained from the Commercial Relations and Exports Department, Board of Trade, Thames House North, Millbank, London, S.W.1.

ROYTON, September 6—Supply of gas cookers, boilers, etc., for the Urban District Council. The Surveyor's Office, Cardigan Street, Royton, Lancs.

CHATTERIS, October 4—Contract No. 2—Provision and laying of about 900 yds. of 7-in. dia. and about 100 yds. 3-in. dia. spun-iron pipe water mains, for the Urban District Council. Elliott & Brown, consulting engineers, Stanley House, Pelham Road, Nottingham. (Fee, £3 3s., returnable.)

Exhibition of Photography

The Royal Photographic Society's 94th Annual Exhibition of Photography will be held at 16, Princes Gate, London, S.W.7, in two sections: Pictorial, Colour and Stereoscopic from September 9 to October 2, and Scientific, Nature, Record and Technical from October 8 to 26. The exhibition will be opened by Mr. Percy W. Harris, President of the Society, on September 8. This year 5,300 entries were received (of which 863 were accepted) from all parts of the world. The exhibition will be open daily, including Saturdays (10 a.m. to 5.30 p.m.) and Sunday afternoons. There will be special film shows and displays of lantern slides and transparencies in the lecture theatre of the Science Museum.

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GLASGOW, C.2. 93, Hope Street, Central 9969

NOTICE

Situations advertised under this heading are available only to applicants excepted from the Control of Engagement Order, 1947, No. 2021.

Replies to Box Numbers to be addressed to:— "Foundry Trade Journal," 49, Wellington Street, London, W.C.2.

SITUATIONS WANTED

FOUNDRY MANAGER (35), desires change; ferrous, non-ferrous. First-class practical technical knowledge of pattern making, green, dry, loam moulding, metal control. Able to achieve top rate production by machine, plate, loose pattern methods, large or small foundry. Strict disciplinarian with excellent record of labour control.—Box 268, FOUNDRY TRADE JOURNAL.

PATTERNMAKER, 38, disengaged, desires progressive position, pattern-shop or foundry. A.M.I.B.F., City and Guilds, Foundry Practice and Science. Ability to design pattern equipment for mechanised production, general engineering machine tools and rapid repetition hand moulding. Experience in checking, works orders, etc. Knowledge of foundry technique.—Box 266, FOUNDRY TRADE JOURNAL.

TECHNICAL DIRECTOR seeks to join small foundry enterprise, part-time only; own diecasting plant and small additional capital available. Manchester area only.—Details to Box 272, FOUNDRY TRADE JOURNAL.

YOUNG ENGINEER, responsible for design, development and maintenance of foundry plant, desires change. Would consider position with a firm desiring the services of a technical Foundry Engineer.—Box 290, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

AN EXPERIENCED FOUNDRY SUPERINTENDENT is required by a company located 30 miles South of London, to take charge of Iron Foundry producing precision machine moulded castings of high quality; capacity 10 tons per week; commercial and aircraft aluminium castings, capacity 10 tons per week; die castings, gravity and pressure, capacity 15 tons per week; and some bronze, gunmetals and magnesium castings; and a well-equipped Pattern Shop serving these Departments. The successful candidate must be capable of controlling the estimating and ratefixing of the Departments and obtaining the maximum high quality production. The position offers considerable interest and scope for a man with the necessary experience, energy and initiative; it will be permanent and progressive, and remuneration will include a fixed per annum salary plus a percentage on the gross profits of the Departments. Applicants should give full details of age, experience, positions held, and state in confidence where at present employed, salary required, and when at liberty.—Apply Box 260, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT *Contd.*

A LARGE STEEL FOUNDRY manufacturing wide ranges of Carbon and Alloy Steels, requires a DEPUTY to the present Head of the Foundry. Candidates must have a wide practical Steel Foundry experience, combined with suitable qualifications in Metallurgy, and a University Degree or equivalent is essential. The appointment offers wide scope and excellent prospects.—Apply in the first instance to Box 664, DORLAND ADVERTISING, 18/20, Regent Street, London, S.W.1, stating age, qualifications and experience to date, with positions held, and an indication of the salary required.

A BEDFORDSHIRE engineering firm operating a small specialised iron foundry producing castings in all weights up to 5 cwts., requires a young energetic FOREMAN. Applicants must have had extensive practical experience, coupled with adequate technical knowledge in the latest production methods employed in all branches of up-to-date jobbing and repetition foundries. Competence in training labour and leading men to achieve high outputs is of prime importance. The selected man will share in the staff profit bonus, and have the opportunity of later qualifying for the position of manager.—Write Box 292, FOUNDRY TRADE JOURNAL.

CUPOLA OPERATOR; first-class work; only efficient man need apply; state experience and salary.—Box 296, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN required for jobbing iron and non-ferrous foundry in south-west London area; must be practical man with good all-round experience of hand and machine castings; state age, experience and salary required.—Box 270, FOUNDRY TRADE JOURNAL.

REQUIRED.—Thoroughly experienced PATTERNMAKERS (Wood and Metal) and IRON MOULDERS.—Apply personally to H. C. HOPPER (KINGSTON), LTD., 65, Hampden Road, Kingston-on-Thames.

SKILLED MOULDER wanted in Birmingham. Man of initiative to work small Foundry for prototype work in wide variety of Non-Ferrous Alloys.—Box 274, FOUNDRY TRADE JOURNAL.

TECHNICAL Sales Representative required by a reputable firm of iron-founders for the Midlands area. Applicants must have engineering and previous sales experience. Preference will be given to applicants with a knowledge of modern foundry practice as applied to repetition production methods.—Replies, stating age, qualifications, salary required, etc., in confidence, to Box 282, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

EXCELLENT opportunity energetic practical FOUNDRYMAN, preferably already calling trade, sell new proposition interesting all foundries.—Box 952, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN (Non-Ferrous) required for London Foundry. Must be fully experienced in high class engineering work. Strict disciplinarian. Knowledge of alloys to specification essential.—Write, stating age, technical qualifications, references (copies only), full details of experience and salary required, to Box 248, FOUNDRY TRADE JOURNAL.

FIRST class experienced SUPERINTENDENT required for iron and brass foundry undertaking with own patternshops engaged on general engineering castings up to 10 tons and machine moulding. First class detached house available for successful applicant. Applicant please state full experience, technical qualifications, salary required, when available, etc.—Box 288, FOUNDRY TRADE JOURNAL.

GREY IRON FOUNDRY in Black Country require an experienced man about 35 years of age, to take charge of Fettling and Warehouse Depts.—Write, stating age, experience and salary required, Box 276, FOUNDRY TRADE JOURNAL.

GENERAL FOUNDRY FOREMAN for High Class and Pressure Production; real live man; iron, aluminium, brass and gunmetal; state full details: experience, and salary expected.—Box 294, FOUNDRY TRADE JOURNAL.

MAN for Laying Out Patterns, and able to produce working odd sides, complete; real progressive job for the right adaptable pattern moulder and general repair man for foundry.—Box 298, FOUNDRY TRADE JOURNAL.

METALLURGIST required to control Heat Treatment in Forge Department of large enginering works. Degree preferred, but not essential. Previous experience an advantage, but consideration given to man possessing suitable background to train for this work. Age up to 30.—Address, 2483, WM. PORTEOUS & Co., Glasgow.

MOULDERS, first class, for jobbing work in iron foundry. Good rates of pay.—Apply to Messrs. H. C. HOPPER (KINGSTON), LTD., 65, Hampden Road, Kingston-on-Thames.

MIDLANDS Iron Founders specialising in high quality products, require two TECHNICAL REPRESENTATIVES for Yorkshire and N.E. Coast, and London. Knowledge of foundry products is not essential; suitable applicants will be required to spend a probationary period in the works. Good salary and commission will be paid.—Write, stating age and previous experience, Box 284, FOUNDRY TRADE JOURNAL.